INSTRUCTION MANUAL

MODEL 304TDL

TRACKING
WAVE AND SPECTRUM ANALYZER

Quan-Tech®
Div. of KMS Industries, Inc.

Specialists in Electronic Instrumentation

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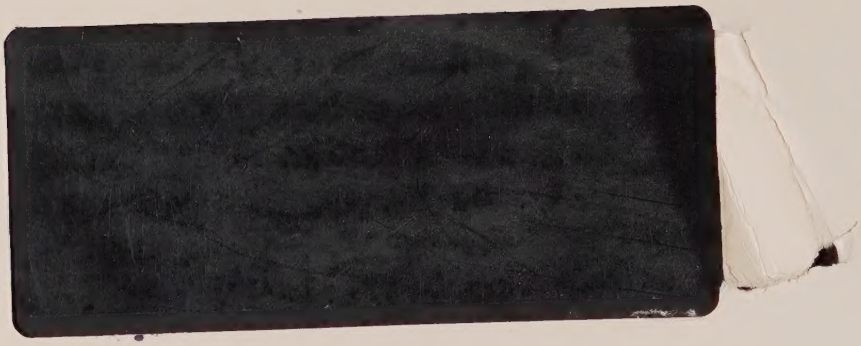

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FOR SERIAL NO. [redacted]

Q U A N - T E C H

DIVISION OF KMS INDUSTRIES, INC.

43 SO. JEFFERSON ROAD WHIPPANY, NEW JERSEY 07981

201-887-5508

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CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. We will then advise you of the disposition to be made of the equipment and arrange for repair or replacement. Include model number and serial number when referring to this instrument for any reason.

WARRANTY

Quan-Tech Division KMS Industries, Inc. warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and to replace any defective parts thereof. Electronic tubes and batteries are specifically excluded from any liability. This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misadjustments, misuse, or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

Calibration checks of this instrument can easily be made in accordance with the instruction manual. Routine readjustments **should never** be attempted. If, however, the instrument has been damaged and requires recalibration or alignment, explicit calibration procedures as defined in the instruction manual **must** be followed.

If any fault develops, the following steps should be taken:

1. Notify us, giving full details of the difficulty, and include the model number and serial number. On receipt of this information, we will give you service data or shipping instructions.

2. On receipt of shipping instructions, forward the instrument prepaid, to the factory. If requested an estimate of the charges will be made before the work begins provided the instrument is not covered by the warranty.

SHIPPING

The instruments should be packed in their original containers, or in a strong exterior container and surrounded by two inches of shock absorbing material.

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201-887-5508

A. DESCRIPTION

The Model 304TDL is a multi-purpose instrument. It is not only useful as a precision wave analyzer for harmonic measurements and Fourier analysis of complex signals, but its three selectable flat-top bandwidths make it ideally suited for spectral density analysis of random signals.

The Model 304TDL features electronic tuning, using a stable voltage controlled oscillator and offers a five digit display (i.e. resolution to 0.1 Hz). A six position MODE switch controls the tuning functions. In the MODE OFF position the instrument acts as a normal, manually tuned wave analyzer. In the AFC position the Analyzer will track a drifting signal and follow it over a limited frequency range determined by the bandwidth. In the TRACK position, the instrument will lock onto a signal and follow it over the whole or discrete portions of the tuning range. In the SWEEP position, the Analyzer will start at the frequency to which the unit is tuned, and scan upward in frequency over the whole or discrete portions of the tuning range, as determined by a sweep increment switch. In the SEARCH & TRACK position, the instrument will scan as in the SWEEP position, until it finds a signal, whereupon it will lock onto the signal and track it as in the TRACK mode. If the signal disappears, the analyzer will continue to scan automatically until the original signal or a new one is found. Since the sweep time, sweep increment, averaging time, and bandwidth are interdependent, a red light will appear if the various switches are set to a combination which would lead to erroneous results. With the MODE switch in the EXT position, the instrument may be tuned by an external DC voltage.

Two or more Model 304TDLs may be connected together without modification to form a multi-channel, master-slave analyzer system suitable for mechanical impedance and transfer function analysis.*

* In multi-channel installations, where the slaved units never need to work independently, we recommend the Model 1304L, which has a built-in phase meter but no tuning or sweep features. Mechanical impedance and transfer function analysis is simplified at a considerable saving in cost.

SWEEP TIME:	5, 50, 500, or 5000 seconds, switch selectable.
SWEEP RANGE:	50, 100, 500, 1000 or 5000Hz, switch selectable.
SWEEP MODES:	Single or Automatic, with reset.
EXTERNAL MODE:	±5 volts for ± sweep range from tuned frequency.

ANALOG OUTPUTS:

SWEEP ANALOG:	0 to +5 volts for any sweep increment; available at front panel and rear connector.
METER ANALOG:	0 to +1 volt proportional to meter deflection; available at front panel and rear connector.
B F O:	Sine wave output at the frequency to which the instrument is tuned. Variable to approximately 1 volt RMS into 600 ohms.
RESTORED:	A replica of the input signal, filtered in accordance with tuning and bandwidth. Variable to approximately 1V RMS into 600 ohms.

The following are available at rear connector only.

FREQUENCY ANALOG:	A positive DC voltage where 1 millivolt equals 1Hz.
PHASE ANALOG:	In-phase and quadrature components, each equal to approximately 1 volt peak-to-peak for full scale deflection.
MASTER-SLAVE CONNECTIONS:	10KHz crystal controlled and 10 to 15KHz variable.
POWER INPUT:	117/234 VAC, 50 to 400Hz, 15 Watts.
DIMENSIONS:	16" Wide x 8" High x 12" Deep. (Includes feet and handles)
WEIGHT:	30 lbs.

SECTION 2 - OPERATION

A thorough understanding of an instrument and its principles of operation greatly enhance its usefulness. The Model 304TDL Wave and Spectrum Analyzer is a precision instrument capable of performing accurate signal analysis. For the most effective application of this equipment we strongly recommend that the prospective operator read Section 3, the Theory of Operation, before using the instrument.

A study of both the block diagram and the following description, along with the panel markings, will help to familiarize the operator with the functions of the various panel controls.

A. DESCRIPTION OF CONTROLS, INPUTS AND OUTPUTS

1. MANUAL TUNING - The COARSE and FINE controls can each change the frequency of the voltage controlled oscillator (VCO), thereby tuning the instrument. The controls differ in both range and resolution, but are alike in that each control precisely converts angular motion to a change in frequency of the VCO.

2. AUTOMATIC TUNING MODES - In addition to manual control of the VCO, provision has been made to electronically tune it in any of several modes as selected by the MODE switch.

   a. In the AFC mode, the instrument will follow a signal which moves no more than approximately four instrument bandwidths.

   b. In the TRACK mode, the instrument will track a moving signal over selectable increments of the instrument tuning range. Increment width is selected by means of the RANGE control.

   c. In the SWEEP mode, the operator may scan in its entirety or incrementally, the spectrum from 1Hz to 5KHz. The increment width again is selectable by means of the RANGE control. The scan time per range increment is selectable by means of the TIME control (5 to 5000 seconds).

   d. The SEARCH AND TRACK mode is a combination of the SWEEP and the TRACK mode. One may electronically scan the spectrum or portions thereof, as in the SWEEP mode. When a signal of given amplitude, as determined by the TRACKING THRESHOLD is found, the instrument will automatically switch to the TRACK mode and track the signal. If the signal moves beyond the range increment or drops below the

pre-set threshold, the instrument will revert to the scanning mode until it once again finds a signal.

e. Provision has been made for the operator to externally program the electronically tuned VCO by means of a connector at the rear of the instrument. This function is accomplished with the MODE switch in the EXT position.

f. The RESET/SINGLE/AUTO switch provides for single or repetitive scanning in the SWEEP or SEARCH and TRACK modes of operation.

The RESET is an inhibit position for the AFC, SELECTIVE SWEEP, or SEARCH AND TRACK modes. An analog voltage is available at the SWEEP MONITOR jack for operating oscilloscopes, recorders, etc.

MASTER/SLAVE operation

This mode of operation is controlled by two switches at the rear of the Model 304TDL. For normal or master operation, the MASTER/SLAVE switches are left in the MASTER position. The switches are thrown to the SLAVE position of one wishes to drive one or more 304TDLs as slave units, subordinate to a 304TDL designated as MASTER. For instance, if one wishes to make simultaneous electronic measurements of two or more points related in phase and amplitude by some complex transfer function, one may use two or more 304TDL Wave Analyzers as slaved units, driven by the master unit.

SENSITIVITY

The METER MULTIPLIER, VARIABLE GAIN and MILLIVOLTS FULL SCALE controls set the instrument's sensitivity and provide for a combined range of 130 db. The METER MULTIPLIER and VARIABLE GAIN controls are associated with the input circuits and serve to adjust the input signal level to the correct value for analysis. The MILLIVOLTS FULL SCALE switch is, in essence, a range switch for the voltmeter. The sensitivity of the Analyzer is increased in 10 db increments as this control is rotated counterclockwise. For absolute amplitude measurements, the 20 db VARIABLE GAIN control should be rotated clockwise to the CALIBRATED position, the meter will then read directly in millivolts times the METER MULTIPLIER.

In the LOG position of the MILLIVOLTS FULL SCALE switch, the instrument sensitivity is 1000 mv times the METER MULTIPLIER setting. The dynamic range in this mode of operation is 70db, which can be read on the lower DB scale provided.

SELECTIVITY

The overall passband of the system is controlled by the BANDWIDTH switch and may be set to 1, 3, 10, 30, or 100 Hz.

METERING

The METER T.C. switch provides for the selection of meter averaging times. The operator will find it helpful in that the averaging time can be changed by the same ratio as the system bandwidth, namely, 10:1. The selectable averaging time is of particular usefulness in the measurement of noisy signals.

The METER ZERO controls provide a means of periodically balancing critically matched circuits which are subject to change with time and temperature. Circuit unbalance is indicated by a finite meter reading with no signal applied and should be "zeroed out" for correct operation.

For recording purposes, the METER ANALOG voltage is made available at both a jack on the front panel and at a connector at the rear of the instrument.

BFO AND RESTORED

The BFO is a sine wave equal to the frequency to which the instrument is tuned, whereas the RESTORED signal is equal to the input signal after it has been passed through the selected filter and therefore is only available when the instrument is tuned to an input signal.

B. INITIAL OPERATION

1. Connect the instrument to a suitable source of power. Refer to the plate located near the power cord for the voltage and frequency for which the instrument is wired.

Allow at least 10 minutes for the instrument to stabilize before making any adjustments.

5. Zero the meter as follows:

   a. Set the frequency such that the instrument is tuned neither to an incoming signal nor the zero frequency carrier.

   b. Turn the MILLIVOLTS switch counterclockwise to progressively more sensitive ranges. As the sensitivity of the instrument is increased, a residual voltage may be discernible. Alternately adjust the METER ZERO controls for a minimum meter reading, adjusting for the best possible null on the most sensitive range. (This should be less than 2% of full scale).

   NOTE: The instrument is now ready for operation. However, for best performance, the above procedure should be repeated periodically.

OPERATION

The actual procedure for instrument operation depends on the test to be performed. A typical example of manual operation is as follows:

To a 1 volt, 1KHz signal is to be analyzed for harmonic distortion.

1. Set BANDWIDTH switch to 100Hz.

2. Set MILLIVOLTS FULL SCALE switch to 1000.

3. Set METER MULTIPLIER switch to X1.

4. Turn the VARIABLE GAIN control clockwise to CALIBRATED position.

   Select METER T.C. of .1 sec.

5. Connect the signal to the INPUT.

6. Tune the FREQUENCY COARSE control to the 1KHz signal.

Now that both the amplitude and frequency of the fundamental signal are known, measure the second harmonic content by tuning the frequency to twice the fundamental frequency (approximately 2 KHz). Rotate the MILLIVOLTS FULL SCALE switch counterclockwise until the meter reads mid-scale. This measure of the second harmonic may now be referred to the fundamental signal by expressing its amplitude in percentage of, or decibels below one volt. Similarly, by successively tuning to 3, 4 and 5 KHz, the amplitudes of the third, fourth and fifth harmonics of the fundamental may be measured.

D. AUTOMATIC MODES

1. AFC

a. Adjust the instrument as in steps 1 thru 7 of MANUAL OPERATION.

b. Set the SINGLE/AUTO/RESET switch to RESET position (effective AFC inhibit).

c. Set MODE switch to AFC position.

d. When SINGLE/AUTO/RESET switch is switched to either SINGLE or AUTO, the AFC becomes effective.

The AFC will hold for approximately four times the BANDWIDTH switch setting.

2. TRACK

a. With MODE switch in OFF position, tune the instrument to a desired signal component as in the MANUAL OPERATION Section.

b. Set RESET/SINGLE/AUTO switch to RESET position.

c. Use the RANGE switch to select the frequency range over which it is desired to track the signal.

d. Choose the bandwidth and meter time constant as required.

NOTE: In the interest of providing maximum versatility, the bandwidth, sweep, and averaging time controls have not been interlocked such as to always provide maximum accuracy. The operator must therefore consider with care his choice of setting.

The field of waveform and spectrum analysis is both broad and complex. There are, however, several excellent texts and articles published on the subject and therefore no attempt will be made in this short manual to cover it thoroughly. Instead, listed below are a number of basic formulae and notes intended merely to serve as a guide to effective use of the equipment.

e. To initiate the SWEEP, set the RESET/SINGLE/AUTO switch first to RESET then back to either the AUTO or SINGLE position.

(1) AUTO - Instrument will continuously scan the selected frequency range.

(2) SINGLE - Instrument will make one scan, stopping at the top of the selected frequency range. The unit will then maintain this tuning until manually detuned or reset.

4. SEARCH AND TRACK

a. The instrument is adjusted as in the SWEEP mode of operation with the exception that when it finds a signal, it will automatically switch to a track mode of operation.

Note that, as in the SWEEP mode, the instrument scans upward through a given range increment, whereas once a signal has been found, the instrument will track both + and - from dial setting by that same range increment.

5. EXTERNAL

In this mode of operation a ±5V control voltage applied to the EXTERNAL input, at the rear connector of the instrument, will electronically tune the instrument by the RANGE increment (f) selected, ± from the tuned frequency (f).

A. THEORY OF OPERATION

The Model 304TDL is basically a dual conversion hetrodyne receiver having a 10KHz first IF and a zero center frequency second IF.

The variable oscillator is a voltage controlled oscillator producing an output variable from 10 to 15 KHz. It is extremely stable and linear, and enables the instrument to be electronically swept over its whole range by an internal ramp in the SWEEP mode. In the AFC, TRACK, and SEARCH & TRACK modes a phase detector controls the variable oscillator enabling the instrument to track a moving signal.

Referring to the Block Diagram, the incoming signal goes through a step attenuator and amplifier into a low pass filter which removes frequencies above 5KHz. The signal is then mixed with the output of the 10 to 15 KHz variable oscillator. The difference frequency is passed through the 10KHz first IF to a pair of second modulators. The two second modulators are driven 90° out of phase by a two-phase 10KHz crystal oscillator. The difference frequencies are then passed through a pair of four-pole maximally flat active low pass filters with selectable cutoff frequencies. The low frequency filtered signals from the two channels are then chopped at 10KHz, again 90° out of phase, and recombined in a summing circuit. The summed signal is amplified and rectified, and drives the meter and meter analog.

Phase information can be obtained from the DC outputs of and R and J channels. The R channel balanced modulator is driven from the same phase of the two-phase 10KHz crystal oscillator as the BFO output modulator. Thus, a signal from the BFO output - of low enough frequency not to have phase shift introduced by the two low pass filters in the circuit - will produce a DC output from the R channel, and none from the J channel, which has been chopped at 90° out of phase. If phase shift is introduced between the BFO output and the input to the first modulator, the R output will decrease and the J output increase until, at 90°, there will be no R output and maximum J output. In this way the Model 304TDL can separate the real from the imaginary parts of a voltage, derived from a device driven by the BFO output.

The BFO output is a constant amplitude signal of exactly the frequency to which the instrument is tuned. It is obtained by mixing the 10KHz fixed oscillator with the 10 to 15KHz variable oscillator and taking the difference frequency. Unwanted higher frequency modulation products are removed by a low pass filter.

The RESTORED signal output is a filtered replica of the input signal exactly equal in frequency and proportional in amplitude. It is obtained by mixing the summed 10KHz signal with the variable oscillator output and taking the difference frequency.

In the AFC and TRACKING modes a phase detector compares the phase difference between the second (RØ,JØ) and fourth (Rn,Jn) poles of both of the low pass filters and produces a DC voltage of proper amplitude and polarity to tune the variable oscillator, so that the desired signal is in the center of the pass band. Control of the variable oscillator by the output of the phase detector is inhibited unless the signal is in excess of the tracking threshold. The output from the phase detector is attenuated in accordance with the bandwidth, tracking range, and tracking time in use.

B. CIRCUIT DESCRIPTION

1. SWEEP GENERATOR & IMPEDANCE CONVERTER - SCHEMATIC 8182

The Sweep Generator itself consists of Q1 and IC1, which form a Miller Integrator that charges C1 linearly with time. When the voltage across C1 reaches a value equal to a reference voltage set by R6, IC2 prohibits further charging of C1. In the RESET mode C1 will remain discharged by Q2.

IC3 is an impedance converter which provides a variable reference voltage to IC4. IC4 also receives a differential reference voltage from the frequency control potentiometer on the front panel. IC4's output is used to drive the frequency analog and to control the frequency of the variable oscillator.

2. VARIABLE OSCILLATOR and DIVIDE BY 4 CIRCUIT - SCHEMATIC 8183

The variable oscillator is basically an extremely stable, free-running multi-vibrator, Q1 and Q7. Its frequency is controlled from the impedance converter by linearly varying the current through Q2 and Q8. This current varies the discharge time of the timing capacitors C1 and C2. Q3 and Q6 function as non-linear collector loads to keep the dissipation in the circuitry at a minimum. Since multi-vibrators are often hard to start, there is a self-starting circuit consisting of Q4 and Q5. The output of the multi-vibrator is isolated and amplified by Q10 to provide maximum stability. The output of the oscillator is divided by 40 to provide the 10 to 15KHz variable oscillator output.

3. PREAMPLIFIER AND FIRST MODULATOR - SCHEMATIC 8184

The input is a 1 megohm step attenuator using reed switches for control. Q1 is a low noise source follower which drives the variable gain amplifier IC1. A low pass filter rejects out of band frequency components which would result in spurious signals in the first modulator. The signal is buffered by IC2 and modulated by the FET chopper Q5. As the instrument is tuned, the chopping frequency varies from 10KHz to 15KHz. A 10KHz I.F. filter suppresses transients and harmonics of the modulator.

4. BANDPASS FILTER, STEP ATTENUATOR and IF LOG AMPLIFIER - SCHEMATIC 8185

The output of the 10KHz bandpass filter feeds amplifier IC1, which in turn feeds the MILLIVOLTS FULL SCALE step attenuator. The IF output amplifiers, IC4 and IC5 are driven directly from the step attenuator.

In the log mode of operation IC2 and IC3 are variable gain amplifiers. The compression elements CR1 and CR2 control the gain which is inversely proportional to the current drive from the meter circuit. The traps in the feedback loop supress unwanted signals generated by the non-linear compression elements.

5. ±10 VOLT SUPPLIES, +5 VOLT SUPPLY - SCHEMATIC 8187

The -10 Volt Supply has as its reference CR7. The error signal between this reference and the midpoint of the voltage divider formed by R7 and R10 is amplified by IC1, which drives the pass transistor Q3. The +10 Volt Supply is identical except for polarity. The +5 Volt Supply is similar except its reference is obtained from a divider, R5 and R6, from the +10 volt supply.

6. METER CIRCUIT - SCHEMATIC 8188

IC1 is a simple buffer to drive the meter and the Meter Analog output. A signal level or threshold detector (IC4) is used to gate the threshold control on in the presence of a signal.

7. SUMMING AMPLIFIER AND DETECTOR - SCHEMATIC 8189

The quadrature chopped signals from the Low Pass Filter Amplifier and Chopper are summed and filtered

by the amplifier consisting of IC1 and its associated filter networks. This results in a 10KHz carrier proportional to the input signal with a bandwidth as selected by the Bandwidth Control and has 24db/oct. skirts. IC4 performs the same function except the signal to be summed is derived from the output of the second pole of the four-pole low pass filters. The first summing network is called the (Normal) channel and the second the Ø (Phase) channel. If the signal is detuned there will be a phase difference between these carrier signals.

A phase detector consisting of squaring amplifiers IC3 and IC5 and a comparator IC6 control the VCO in the Tracking and AFC mode to follow a drifting signal. Q6 is a gate to inhibit action for a no signal condition.

The normal channel signal is amplified by IC2 to drive the RESTORED circuit and the synchronous detector Q1.

8. L.P. FILTER CAPACITOR - SCHEMATICS 8190,8191,& 8192

The capacitors determining the active Low Pass Filter bandwidths are switched into the filter by a series of FET switches as selected by the Bandwidth Switch.

9. LOW PASS FILTERS AND AMPLIFIERS - SCHEMATIC 8193

The R and J Channel filters and amplifiers are identical. Each of the filters consist of two two-pole RC active networks with capacitors selectable by the BANDWIDTH switch. The first section has a gain of approximately 50. The second section has a gain of slightly more than 1. The gains of the two amplifier sections are adjusted so that the overall response is that of a maximally flat or Butterworth filter. Separate outputs are taken from both the second (Ø) and the fourth (N)poles of each filter. The phase difference between these points is later measured in the phase detector and used to control the variable oscillator in the AFC mode. The gain in these channels is pre-set at the factory and should not be changed. Q1, Q2, and Q3 and Q4 are the choppers for the Ø and N channels.

10. FIXED OSCILLATOR AND SECOND MODULATOR - SCHEMATIC 8194

The 10KHz fixed oscillator frequency is derived from a 40KHz crystal oscillator. The 40KHz output is divided by four by IC2. The circuitry is so arranged

as to obtain two 10KHz outputs precisely 90° out of phase. The 10KHz quadrature signals are used to drive the second modulators, Q3 and Q6 through Q4 and Q7. The outputs of the modulators are fed to the two low pass filters. The choppers are also driven from Q4 and Q7.

The Meter Zero controls provide a means of periodically balancing critically matched circuits which are subject to change with time and temperature. Circuit unbalance is indicated by a finite meter reading with no signal applied and should be "zeroed out" (minimum scale reading) for correct operation.

11. TIME BASE - SCHEMATIC 8195

The 10KHz Fixed Oscillator is used to generate an accurate 250 millisecond time base for the frequency readout. IC1, IC2, IC4 and IC5 provide the count-down circuit. IC6 and IC7 generate the latch transfer and counter reset pulses. IC6D inhibits the counter input during the latch transfer.

IC3 decoder strobes the LED readout anodes and the tri-state latches (Counter and Multiplexer board).

If the total count during the 250 m.s. period is less than 100KHz (indicating the VCO is tuned below the fixed oscillator, i.e., negative tuning) IC8 will blank the 1st and 2nd MSD.

12. COUNTER AND MULTIPLEXER - SCHEMATIC 8196

The 400KHz to 600KHz VCO signal is clocked into 5 decade BCD counter. Four times per second the count is transferred to the latches. These latches are strobed by the TIME-BASE generator and drive the BCD to 7 segment decoder on the Readout board. The over-under count drives the blanking circuit on the TIME-BASE generator.

13. BFO AND RESTORED - SCHEMATIC 8197

The output of the VCO through Q1 switches Q2 and Q3, modulators of the fixed oscillator and the N carrier signals. The difference frequency of each modulator is fed through an active low pass filter (4 pole), the output level is adjusted by a variable attenuator placed between the two sections.

CALIBRATION

1. GENERAL

The Model 304TDL is a precision instrument, the accuracy of which depends, in large part, on critically balanced DC circuitry. The circuits in turn are designed to operate over a moderate temperature range. However, the instrument cannot cope with thermal shocks or transients which cause differential temperatures to occur between individual components. The closed-box environment provided by the Model 304TDL case affords its circuits both thermal-transient and electrostatic shielding, thereby resulting in more stable operation. During calibration similar protection may be required in the interest of accuracy. It is also recommended that the "extender board" supplied with each instrument be used in the case of those adjustments which cannot be made without removing the circuit board. If a circuit board must be temporarily removed from its socket, or if the unit is momentarily turned off, be sure to allow the instrument time to restabilize before making further adjustments.

Following is an outline of the setup procedure. It is important that the adjustments be made in the prescribed order, inasmuch as some of them depend upon completion of the previous ones.

C A U T I O N

Included in this procedure are a number of adjustments which require the actual selection and installation of components. These particular adjustments are intended to be made ONLY on new assemblies or those which have received catastrophic damage, necessitating a major overhaul. An asterisk indicates factory selected components on the schematics.

Those adjustable controls not covered in the "Calibration Procedure" should NOT be adjusted. These are set at the factory during initial calibration and will not require further adjustment.

2. Adjustment Procedure Outline

   a. Frequency Determinants

      (1) Power Supplies

      (2) Variable Oscillator and Impedance Converter

      (3) Fixed Oscillator

      (4) Sweep Circuits

   b. Signal Channel

      (1) Meter Zero Adjustments

      (2) R/J Channel Balance

      (3) Calibrate Gain Circuit

      (4) Check Systems Gain

3. Test Equipment Required

a.	VOM	- Avometer or equivalent 20,000 Ohm/Volt
b.	D.C. Voltmeter	- 0.1% Accuracy
c.	Oscillator	- 10Hz to 100KHz, 1 Volt output
d.	VTVM	- HP 400D or equivalent
e.	Oscilloscope	- Tektronix 503 or equivalent
f.	Oscilloscope	- 50MHz response with low-capacitance probe
g.	Frequency Counter	- Range 500KHz, accuracy 0.1%
h.	Decade Attenuator	- GR 1450 or equivalent

4. Initial Setting of Controls

METER ZERO CONTROLS	Midrange
METER T.C.	.1 SEC.
MILLIVOLTS FULL SCALE	1000
BANDWIDTH	100Hz
FINE Control	Midrange
Frequency Readout	00000

METER MULTIPLIER	X1
Variable Control	Calibrated
SWEEP RANGE	5KHz
SWEEP TIME	50 SEC.
Sweep Function	RESET

5. Calibration of Frequency Control Circuits

NOTE: ALLOW INSTRUMENT TO WARM UP FOR 15 MINUTES BEFORE ATTEMPTING THE FOLLOWING PROCEDURES.

a. POWER SUPPLIES Assy 05; Test Equipment; Item b.

(1) Monitor the minus 10 Volt T.P. with D.C. Voltmeter. Should read minus 10 Volts ±100 millivolts. If necessary, adjust R1 for correct reading.

(2) Monitor the plus 10 Volt T.P. Adjust R3 if necessary.

(3) Monitor the plus 5 Volts T.P. 4.75 to 5.25 Volts is within range.

b. SWEEP GENERATOR Assy 01; Test Equipment: Item b.

Front panel controls as "Initial Setting"

(1) Monitor sweep T.P. with Voltmeter. Adjust R2 for 0 volts ±10 millivolts. Set SWEEP to SINGLE. At the end of the sweep period, 50 sec., adjust R6 to 5 volts ±10 millivolts. The above T.P. is also the SWEEP ANALOG.

c. IMPEDANCE CONVERTER Assy 01; Test Equipt: Item b.

(1) Turn Sweep to Reset. Monitor Frequency Analog T.P. with voltmeter. Set FINE Frequency tuning control to midrange and the COARSE tuning control approximately 1/4 turn clockwise from the lower end stop. Adjust Frequency Analog 0 volt adj. (R16) for 0 volts ±10mv. Switch SWEEP to SINGLE, allow instrument to complete sweep, adjust Frequency Analog +5 volt Adj. (R22) to 5 volts ±10mv.

(2) Set Sweep Range to 5KHz. Frequency Analog T.P. should be 5.0 volts ±25mv.

(3) Check Sweep Times. Set SWEEP to RESET, and, using a watch or clock, measure the time for the SWEEP ANALOG or SWEEP T.P. to sweep from 0 to 5 volts when the SWEEP is set to SINGLE. Since this function is used in X-Y plotting of data, the time is not critical, ±20% is adequate. For the longer sweep times a timing of a partial sweep will decrease the test time.

d. VARIABLE OSCILLATOR Assy 02; Test Equipt; Item b.

Front panel controls as in "Initial Setting"

(1) Adjust Variable Oscillator Reference Adj. (+5.25V) R22, using T.P. to +5.25 Volts +10 mv.

(2) Adjust Variable Oscillator Zero Adj.,R1, for 00000Hz on the front panel display.

(3) Tune the COARSE and FINE tuning controls for 5 volts at the Frequency Analog T.P. on Assy 01, then adjust the 5KHz adj. R6 for 5KHz display on the front panel readout.

e. FIXED OSCILLATOR Assy 12; Test Equipment: Item g

(1) No Frequency adjustment is required on the Fixed Oscillator. If there is a question of its frequency, use a scope probe into the counter from the crystal (top terminal). The frequency should be 40KHz ±0.01% at room temperature.

6. Calibration of the Signal Channel

Front panel controls as in "Initial Setting" except, tune the frequenxy readout to 1KHz and set MILLIVOLTS FULL SCALE switch to 3.

a. LOW PASS FILTER Assy 11; Test Equipt; Item C.

(1) Adjust the front panel METER ZERO controls to midrange.

(2) Adjust the COARSE R (R19) and J ZERO (R1) for minimum meter deflection.

(3) Adjust front panel METER ZERO controls for accurate minimum deflection.

(4) Set MILLIVOLTS FULL SCALE Switch to 1000 and apply 1 volt 1KHz sinewave to the

input. Carefully tune either the generator or Model 304TDL to within a few Hz of each other. Then adjust the R-J Bal. control (R17) for maximum meter stability (±2% is acceptable).

b. METER CIRCUIT Assy 06; Test Equipment; Items b and c.

(1) With no signal at the input, tune to approximately 1KHz (be sure the Meter Zero controls are carefully adjusted). Adjust T.C.Bal. (R1) for zero on the meter.

(2) Apply a 1KHz signal and monitor the Meter Analog T.P. Adjust signal level for 1 Volt output, then adjust Meter Cal. adj. (R13) for a reading of 1.0 on the meter.

c. SUMMING AMPLIFIER AND DETECTOR Assy 07; Test Equipment: Items c, d, and e.

(1) With 1 volt 1KHz applied to the input, adjust SYSTEM GAIN with R8 for 1 volt meter reading.

(2) Using the X and Y inputs of a scope monitor the R and J T.P.'s on board 11, Low Pass Filter. A rotating circular pattern will be observed. Set to A.F.C. and SINGLE. Adjust Track Bal. adj. (R38) for minimum rotation. NOTE: Often a phase lock on the signal is obtained, but is not required for A.F.C. operation. Check the Track and Search and Track as above.

(3) Vary the input Frequency and the instrument should follow the signal over approximately ±4 bandwidths in the A.F.C. mode and the required ranges in Track or Search and Track.

(4) Decrease the signal level to approximately 10% of FULL scale; adjust the Threshold Adj. (R29) on Assy 06 until the lock is released.

d. LOG CIRCUIT Assy 06

(1) Tune to 1KHz and apply a 1 volt 1KHz signal.

(2) Switch the MVFS switch to LOG and Meter Multiplier to X1.

(3) Adjust LOG Off Set for 0 dB

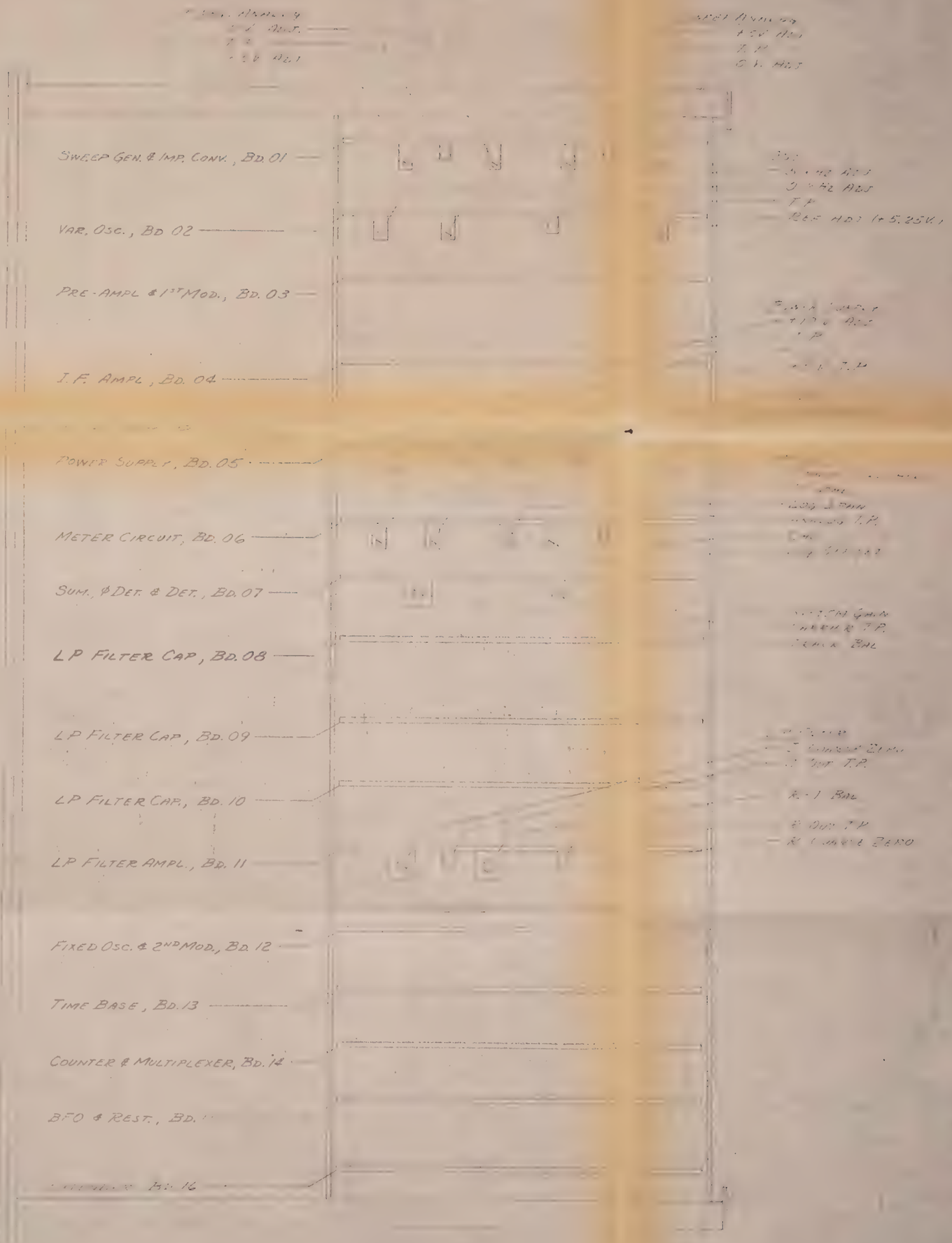
(4) Attenuate the input 40dB and adjust Log Span for a meter reading of -40dB.

NOTE: The above adjustments are inter-dependant, therefore, if the instrument has been grossly misaligned, several adjustments may be required.

(5) Check Log Scale Tracking (±2dB from 0 to -70dB).

TABLE 4 - 1 PLUG-IN BOARD IDENTIFICATION

BOARD NO.	FUNCTION
01	Sweep Generator and Impedance Converter
02	Variable Oscillator
03	Pre-Amplifier and 1st Modulator
04	I.E. Amplifier
05	Power Supply
06	Meter Circuit
07	Summing Amplifier and Detector
08	L.P. Filter Capacitor
09	" " "
10	" " "
11	L.P. Filter Amplifier
12	Fixed Oscillator 2nd Modulator
13	Time Base
14	Counter and Multiplexer
15	B F O and Restored
16	Extender


SWEEP GEN. & IMP. CONV., BD. 01
VAR. OSC., BD. 02
PRE-AMPL & 1ST MOD., BD. 03
I.F. AMPL, BD. 04
POWER SUPPLY, BD. 05
METER CIRCUIT, BD. 06
SUM., Ø DET. & DET., BD. 07
LP FILTER CAP, BD. 08
LP FILTER CAP, BD. 09
LP FILTER CAP., BD. 10
LP FILTER AMPL., BD. 11
FIXED OSC. & 2ND MOD., BD. 12
TIME BASE, BD. 13
COUNTER & MULTIPLEXER, BD. 14
BFO & REST., BD.
TOP VIEW

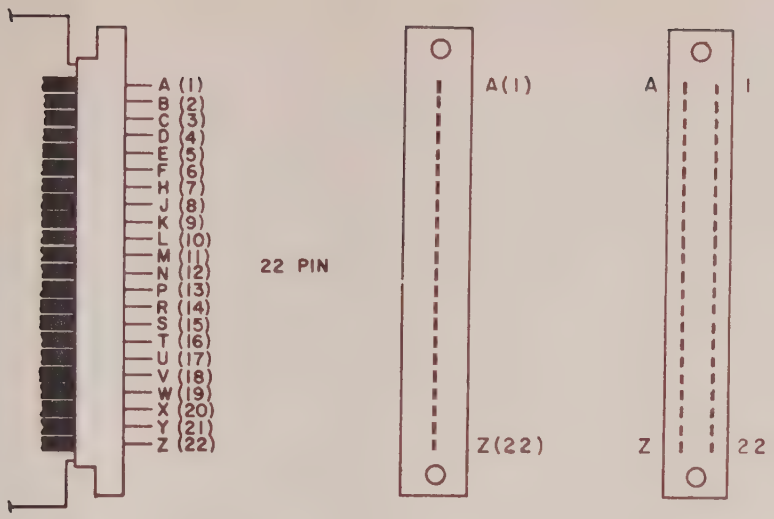


FIG. 1 PRINTED CIRCUIT BOARD LUG IDENTIFICATION

Fig. 1 illustrates the identification and orientation of a printed circuit board and connector utilizing 22 pins.

When a printed circuit board of a lesser number of pins is called for, the same designating sequence shall apply.

When a single sided copper P.C. Board is used, its pin identification shall be as shown in Fig. 1, and its schematic references shall be A(1), B(2), C(3) etc. The copper side faces the observer when viewed as shown at the left.

When using a double sided copper P.C. Board, its pin orientation shall be as shown in Fig. 1 and its schematic references shall be as follows:

a. (A), (B), (C) etc. signifies that electrical connections are made to lettered side of P.C. Board (A side).

b. (1), (2), (3) etc. signifies that electrical connections are made to numbered side of P.C. Board (1 side).

c. A(1), B(2), C(3) etc. signifies that electrical connections are made to both sides of P.C. Board simultaneously, i.e., A and 1 are schematically connected.

SEMICONDUCTOR LEGEND

Changes and improvements in the semiconductor products available for commercial use necessitate type changes from time to time. To eliminate confusion and costly paperwork, many of these changes will be covered in the following legend. The purpose of this legend is to acknowledge the fact that the type number on a semiconductor found in a piece of equipment will not necessarily correspond with the type number given on the schematic diagram.

The legend is not intended to be an interchangeability list although in many cases good quality components* within a given category may be substituted with acceptable results. Normally, replacements should be made using components having the same type number as the component being replaced.

Those components bearing an asterisk on the schematic diagram are factory selected components and should be obtained from Quan-Tech.

*It should be noted that the incoming inspection procedure followed at Quan-Tech includes noise screening on most semiconductors.

TYPE NO. ON SCHEMATIC	TYPE NO. IN EQUIPMENT
1N482A	1N648, 1N3604, 1N3605
1N703	1N748, 1N749
1N709	1N753
1N2859	1N3253, 1N3254
1N2862	1N3254
1N3253	75A4, 1N3254
1N3254	75A4
1N3604	1N3605, 1N4151, 1N482A, 1N648
1N3605	1N3604, 1N4151, 1N482A, 1N648
MPD400	MPD401, 1N5179
TIS73	TIS74, TIS75, 2N4392
TIS74	TIS75, 2N4392
TIS75	TIS74, 2N4392
TI480	2N1613, 2N3566, 2N3643 A322, 2N929
TI494	2N1613, 2N3566, 2N3643, A322, 2N929
UC240	2N4869, 2N3819
2N270	2N3644, 2N3250, 2N3251
2N396A	2N414, 4JX1G759, 4JX1D653, 2N1305, 2N3644, 2N3250, 2N3251
2N414	2N396A, 4JX1G759, 4JX1D653, 2N1305, 2N3644, 2N3250, 2N3251

TYPE NO. ON SCHEMATIC	TYPE NO. IN EQUIPMENT
2N929	A322, A324, A642, 220N2, 2N930, 2N3566, 2N3643, 2N2219
2N1304	2N929, 2N930, 2N1306, 2N3566, 2N3643, A322
2N1306	2N929, 2N930, 2N1304, 2N3566, 2N3643, A322
2N1515	2N3644, 2N3250, 2N3251
2N1613	2N929, 2N930, 2N3566, 2N3643, A322, 2N2219
2N2219	D16C33, 220N2, A322, A324, A642, 2N929, 2N930, 2N3566, 2N3643
2N2603	2N3250, 2N3251, 2N3644
2N3250	2N3251, 2N3644
2N3251	2N3250, 2N3644
2N3566	2N3643, A322, 2N929, 2N2219
2N3643	2N3566, 2N2219, A322, 2N929
2N3644	2N3250, 2N3251, 2N3762
2N3762	2N3250, 2N3251, 2N3644
2N3819	TIS73, TIS74, TIS75, TIS58, TIS59, 2N4869, UC240
2N4392	TIS74, TIS75, 2N3819
2N4869	2N3819, UC240

SCHEMATIC LEGEND

k – 1000

– Screw Driver Adjustment

– Front Panel Control

* – Factory Select

Unless Otherwise Specified:

All Resistances in Ohms

All Capacitances in Microfarads

Meter Multiplier

VHF

Input

Step Atten

Var Gain Amp

Low Pass Filter

Ampl

Modulator

Bandpass Filter

IF Ampl

Step Atten

Lin

Log

Log Comp Amp

From Meter Ckt

IF Ampl

Millivolts Full Scale

Modulator

Selectable Bandwidth 4 Pole Low Pass Filter

1 2 3 4

R Channel Out

Master/ Slave R Channel

R Φ Chopper

2 Phase Crystal Osc.

0°

90°

Summing Circuit

Phase Detector

J Φ Chopper

Modulator

Selectable Bandwidth 4 Pole Low Pass Filter

1 2 3 4

J Channel Out

Master/ Slave J Channel

J Φ Chopper

Summing Circuit And Detector

Time Constant

Meter Circuit

Log Meter Circuit

Log

Lin

To Log Comp Amp

Meter Analog

RMS Millivolts

Carrier Out

±10 Volt Supply

+5 Volt Supply

Modulator

Var Gain Low Pass Filter

BFO Out

Modulator

Var Gain Low Pass Filter

Restored Out

Freq

Range Time

Master

Slave

Var Osc

Impedance Converter

Sweep Voltage

AFC

Track

Search And Track

Sweep Ext

Gain Functions In Accordance With Mode, Bandwith Track Range And Track Speed

Var Slave II

Var Master Out

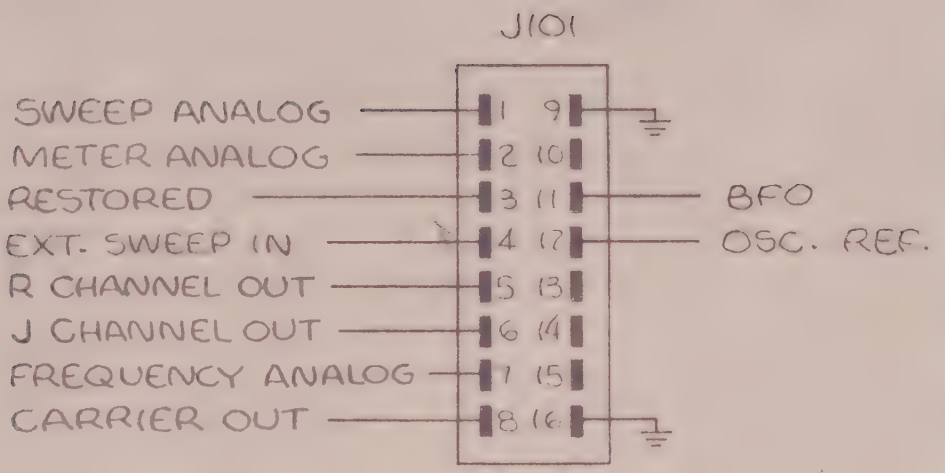
Freq Analog

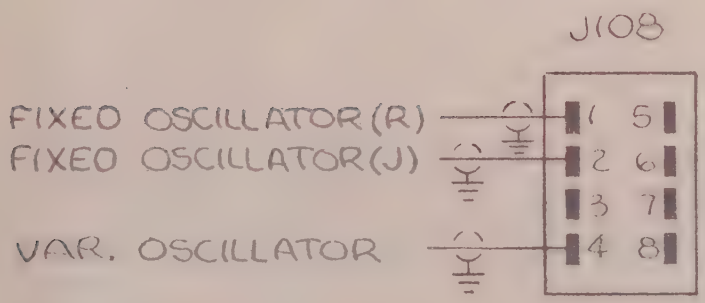
Sweep Analog Also AFC Analog Track Analog

Digital Readout

BLOCK DIAGRAM
MODEL 304TDL
MODEL 306TDL

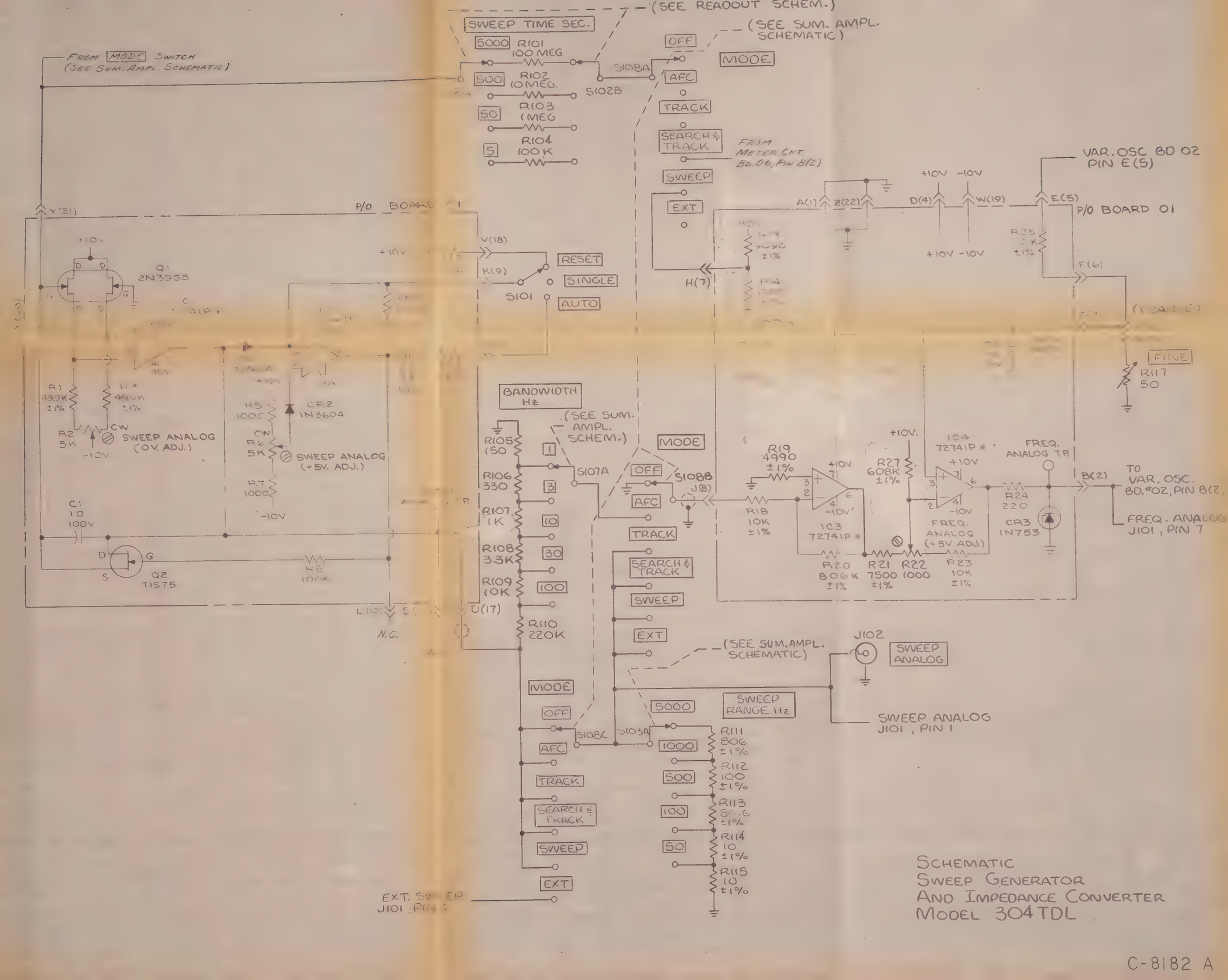
D-8180





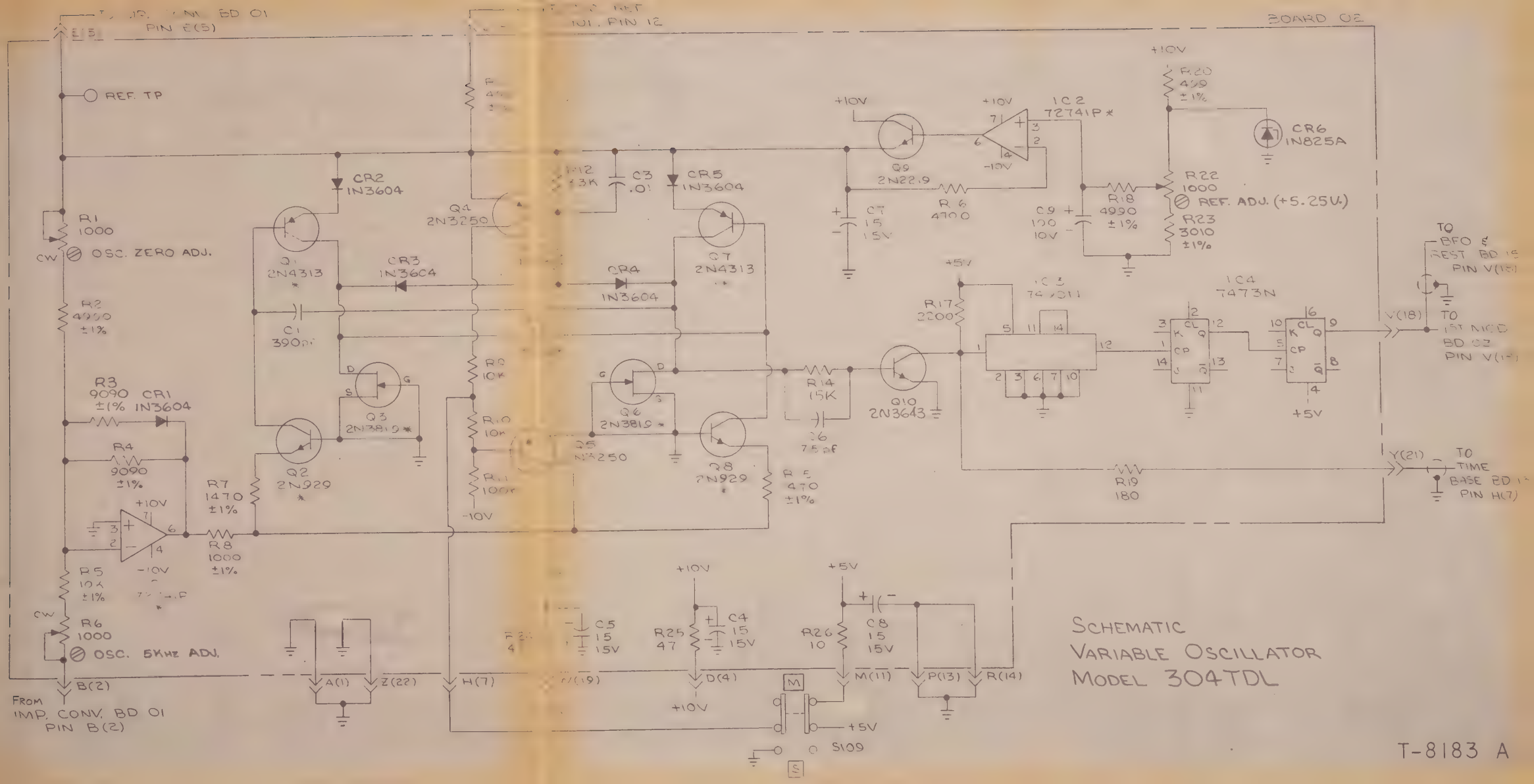
SCHEMATIC
CONNECTORS
MODEL 304TDL

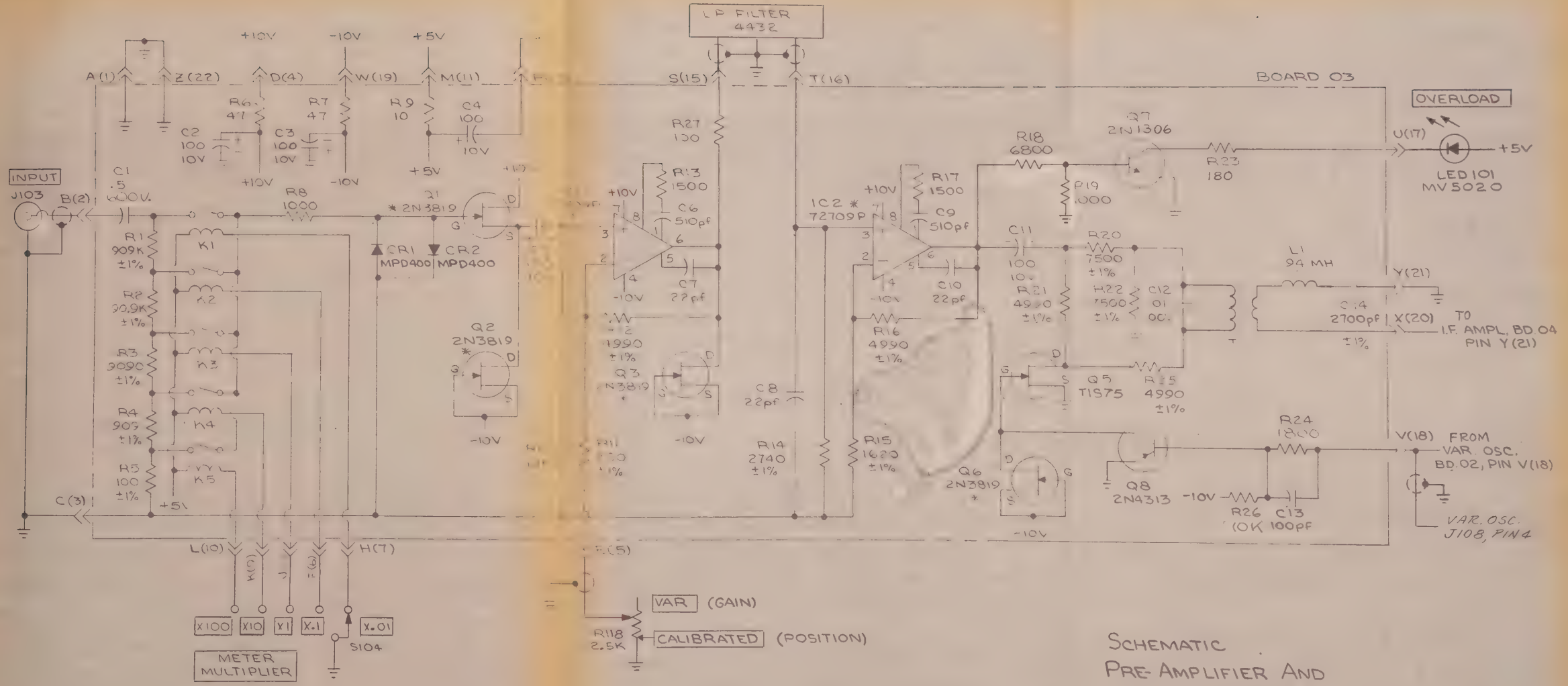
A-8181 A



SCHEMATIC
SWEEP GENERATOR
AND IMPEDANCE CONVERTER
MODEL 304 TDL

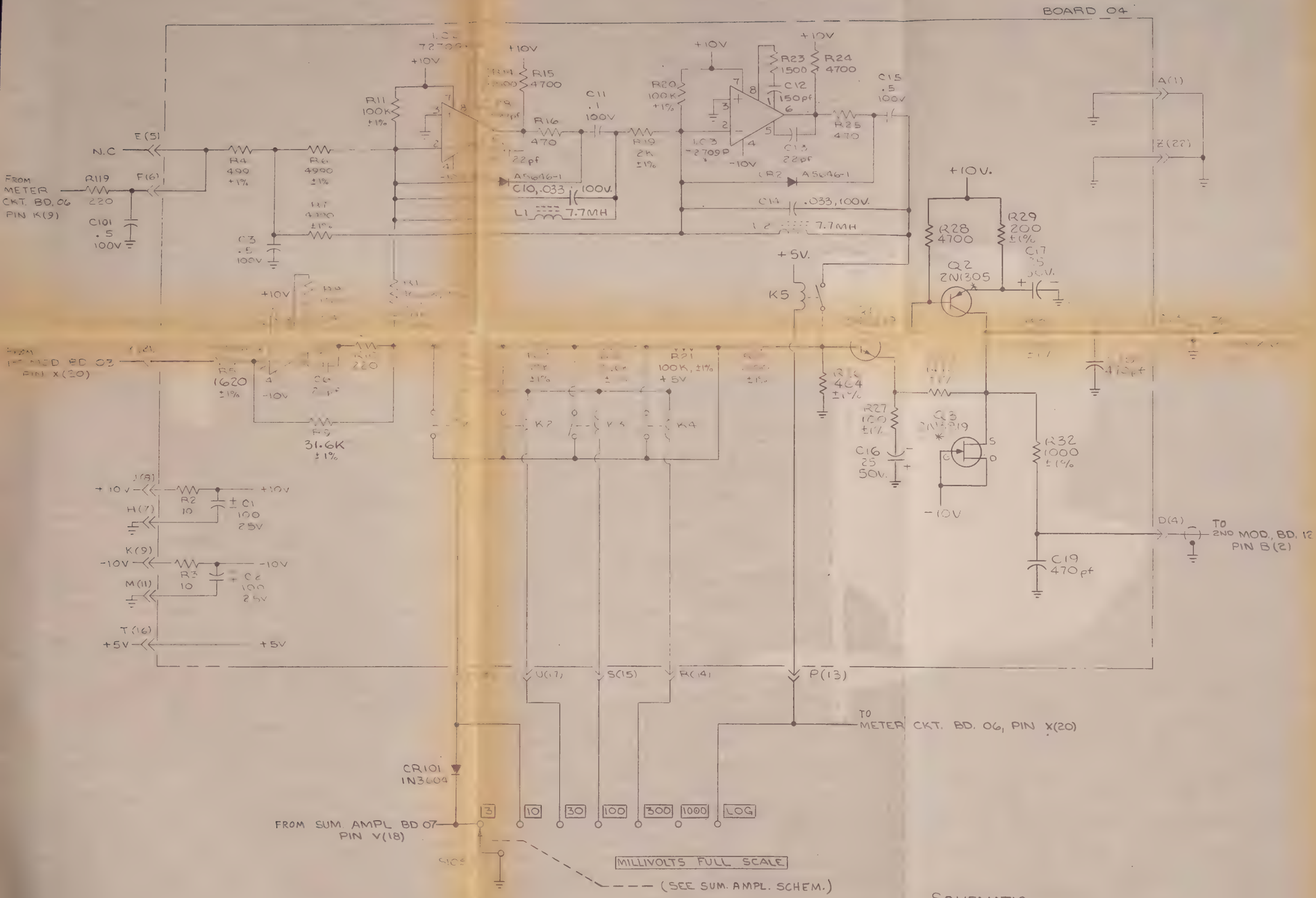
C-8182 A


BOARD 02
REF. TP
R1 1000 CW OSC. ZERO ADJ.
R2 4990 ±1%
R3 9090 ±1%
CR1 IN3604
R4 9090 ±1%
R5 10K ±1%
R6 1000 CW OSC. 5KHz ADJ.
R7 1470 ±1%
R8 1000 ±1%
CR2 IN3604
CR3 IN3604
CR4 IN3604
CR5 IN3604
Q1 2N4313
Q2 2N929
Q3 2N3819
Q4 2N3250
Q5 2N3250
Q6 2N3819
Q7 2N4313
Q8 2N929
Q9 2N2219
Q10 2N3643
C1 390pf
C3 .01
C4 15 15V
C5 15 15V
C6 75 pf
C7 15 15V
C8 15 15V
C9 100 10V
R9 10K
R10 10K
R11 100K
R12 13K
R14 15K
R15 470 ±1%
R17 2200
R18 4990 ±1%
R19 180
R20 499 ±1%
R22 1000 REF. ADJ. (+5.25V.)
R23 3010 ±1%
R25 47
R26 10
IC2 72741P*
IC3 74 ,011
IC4 7473N
+10V
-10V
+5V
CR6 IN825A
FROM IMP. CONV. BD 01 PIN B(2)
TO BFO & REST BD 15 PIN V(15)
TO 1ST MOD BD 02 PIN V(15)
TO TIME BASE BD 13 PIN H(7)
V(18)
Y(21)
A(1)
Z(22)
H(7)
D(4)
M(11)
P(13)
R(14)
S109
SCHEMATIC
VARIABLE OSCILLATOR
MODEL 304TDL
T-8183 A



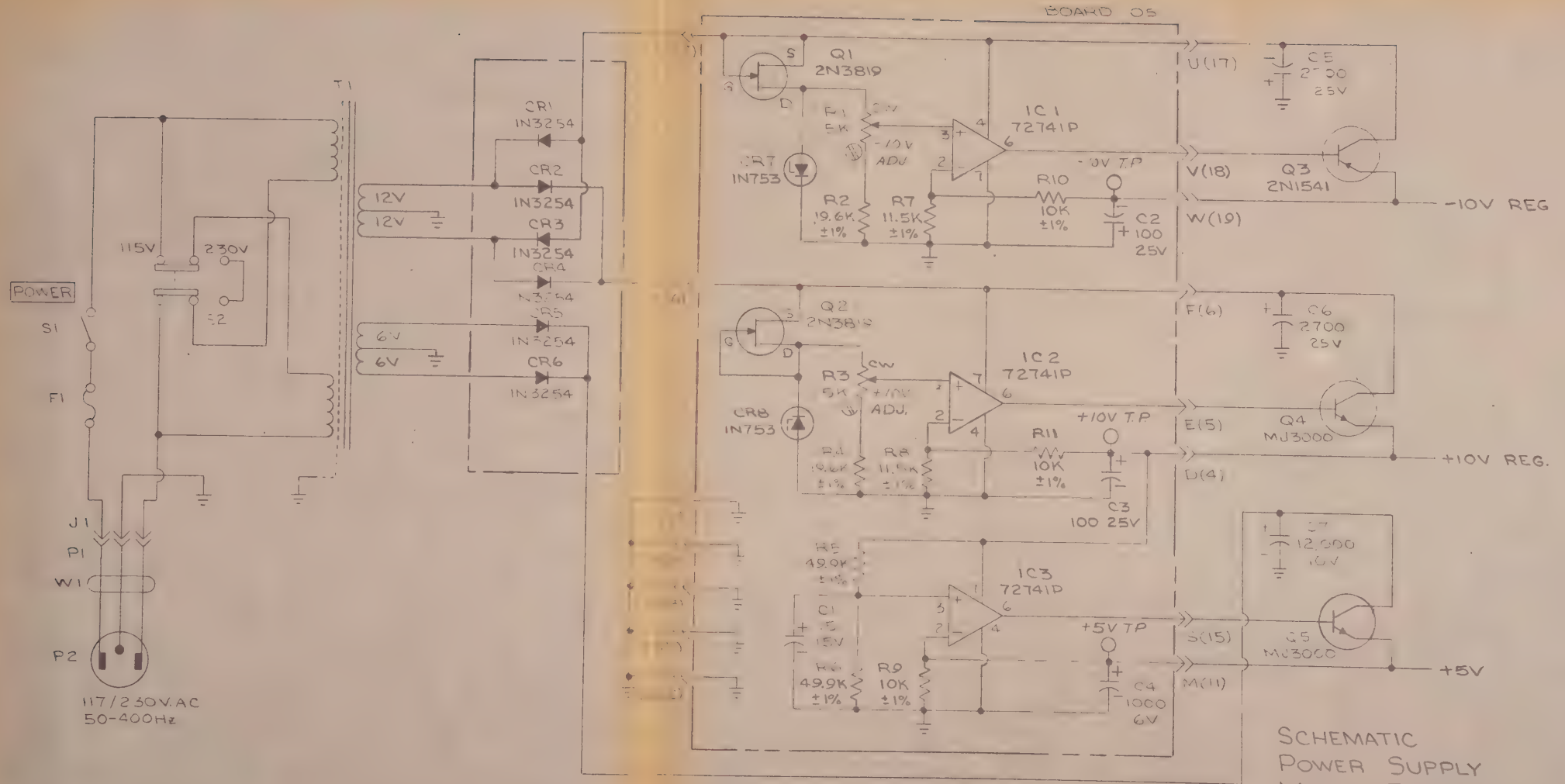
SCHEMATIC
PRE-AMPLIFIER AND
1ST MODULATOR
MODEL 304TDL

T-8184 A



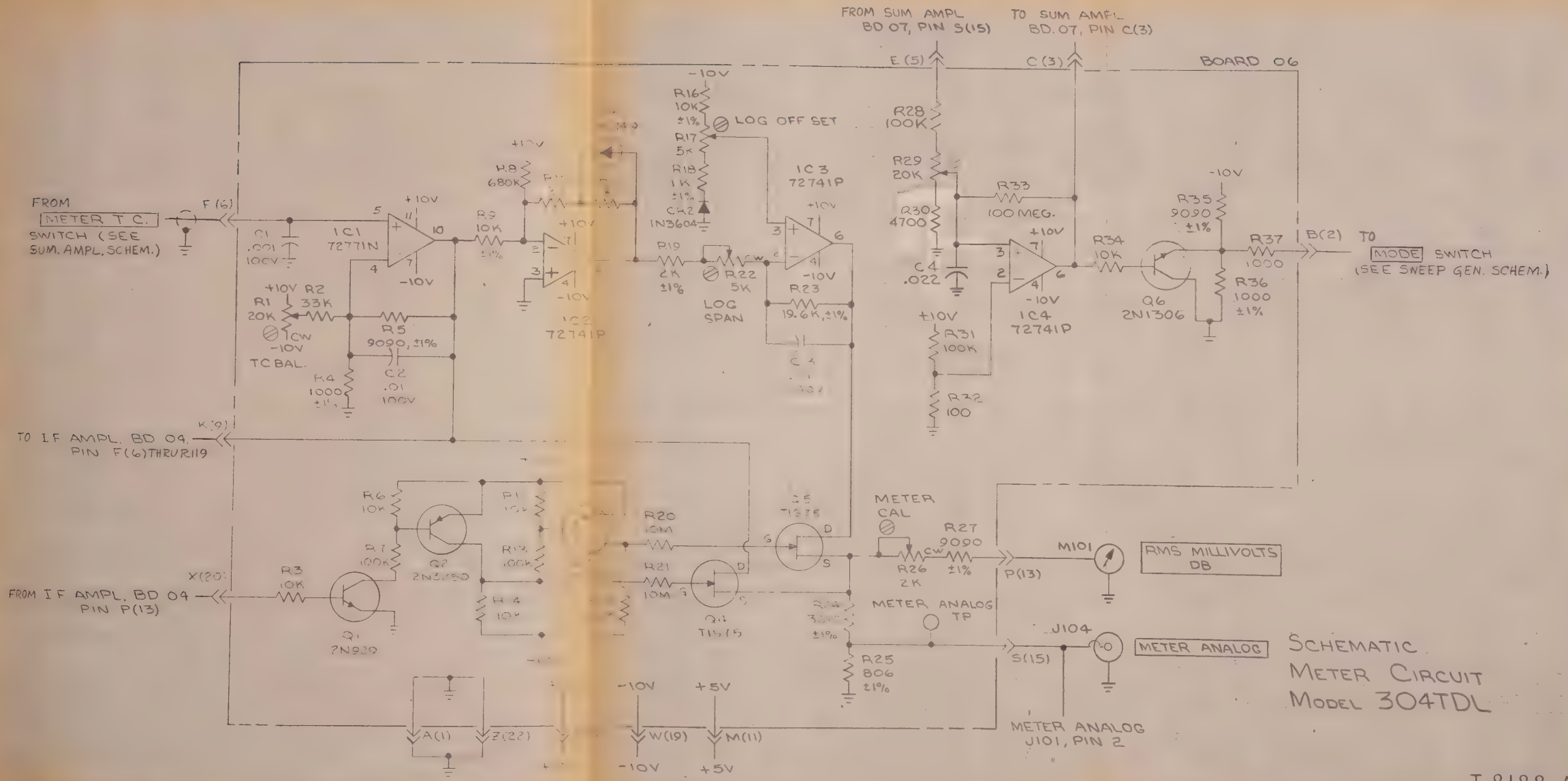
SCHEMATIC
I.F. AMPLIFIER
MODEL 304TDL

C-8185 B



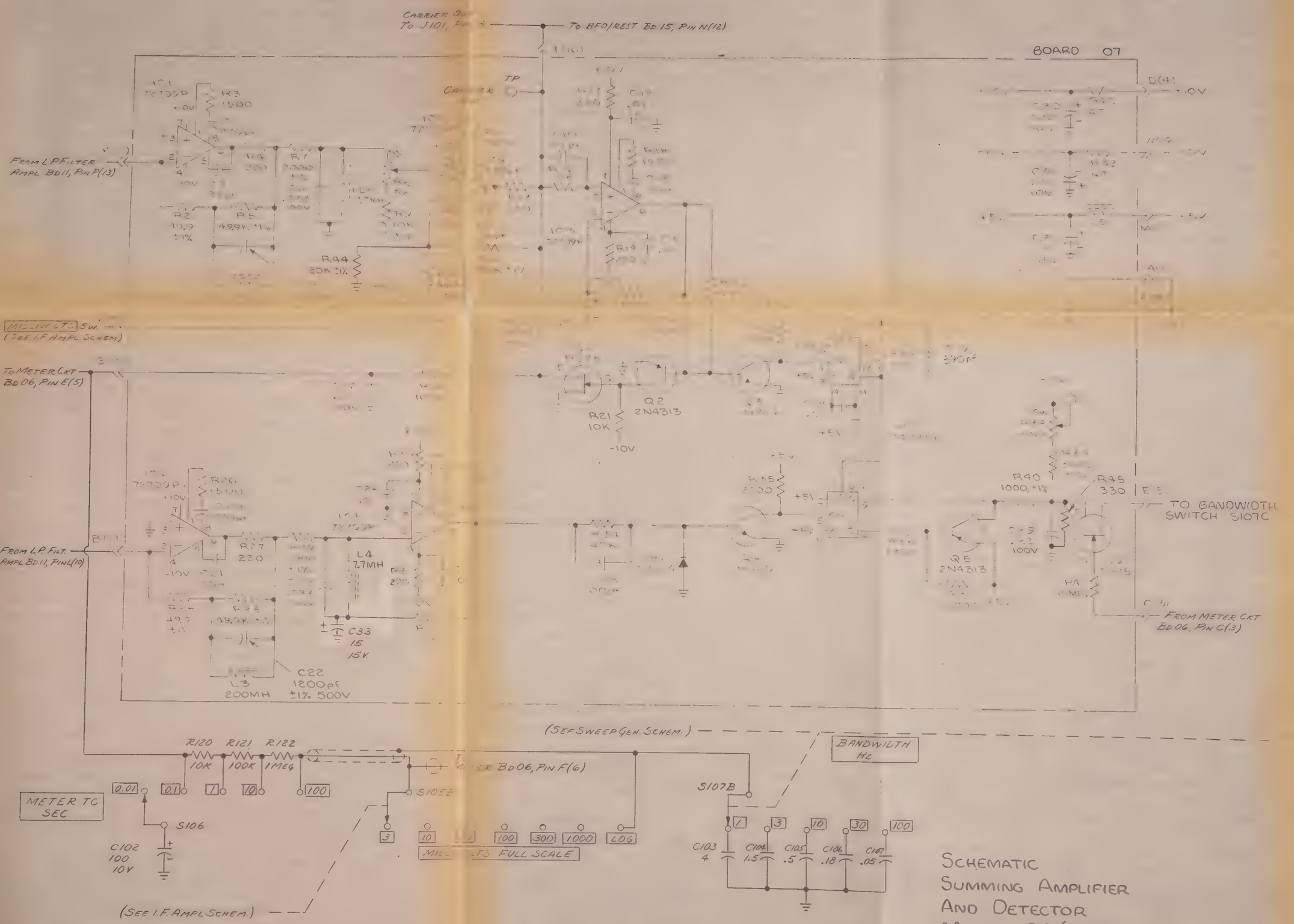
SCHEMATIC
POWER SUPPLY
MODEL 304TDL

T-8187 A



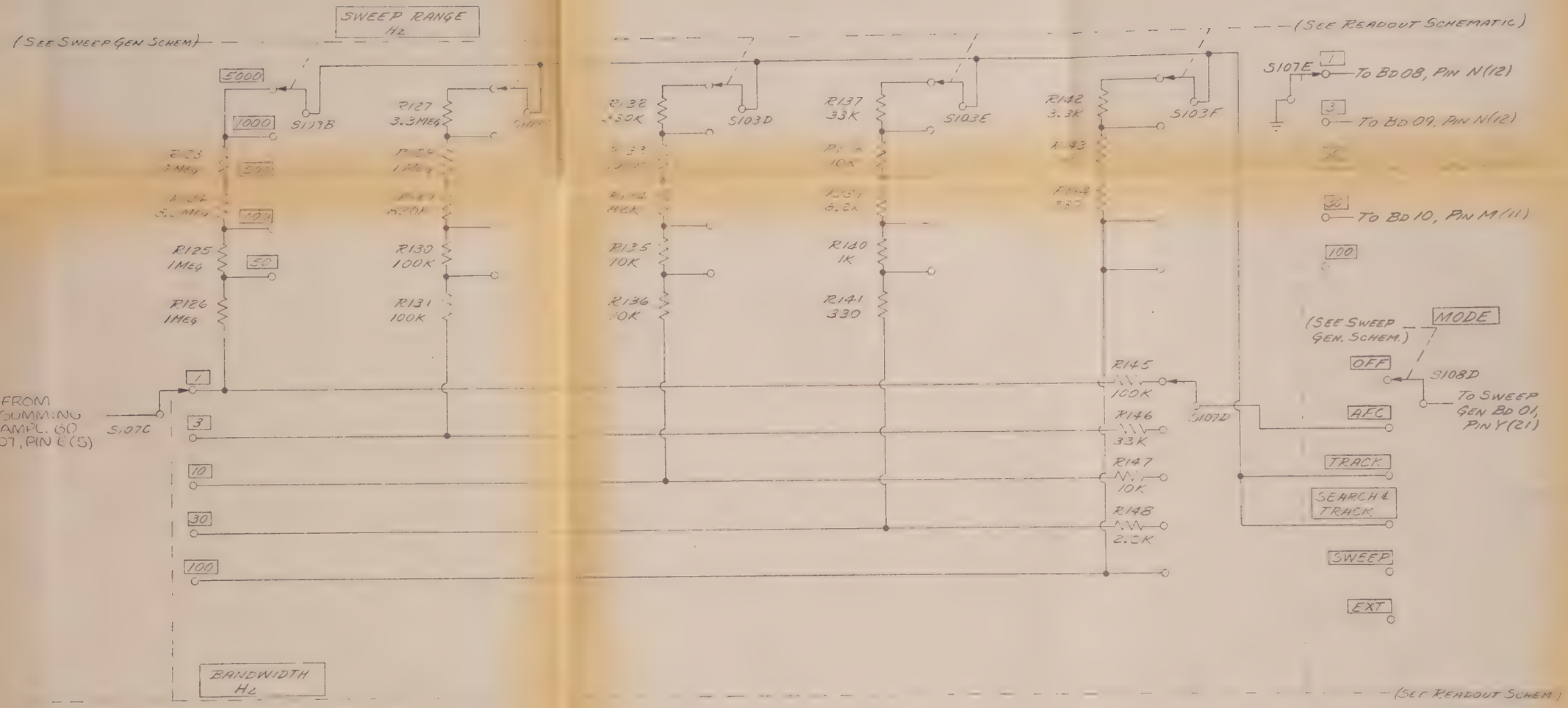
SCHEMATIC
METER CIRCUIT
MODEL 304TDL

T-8188 A



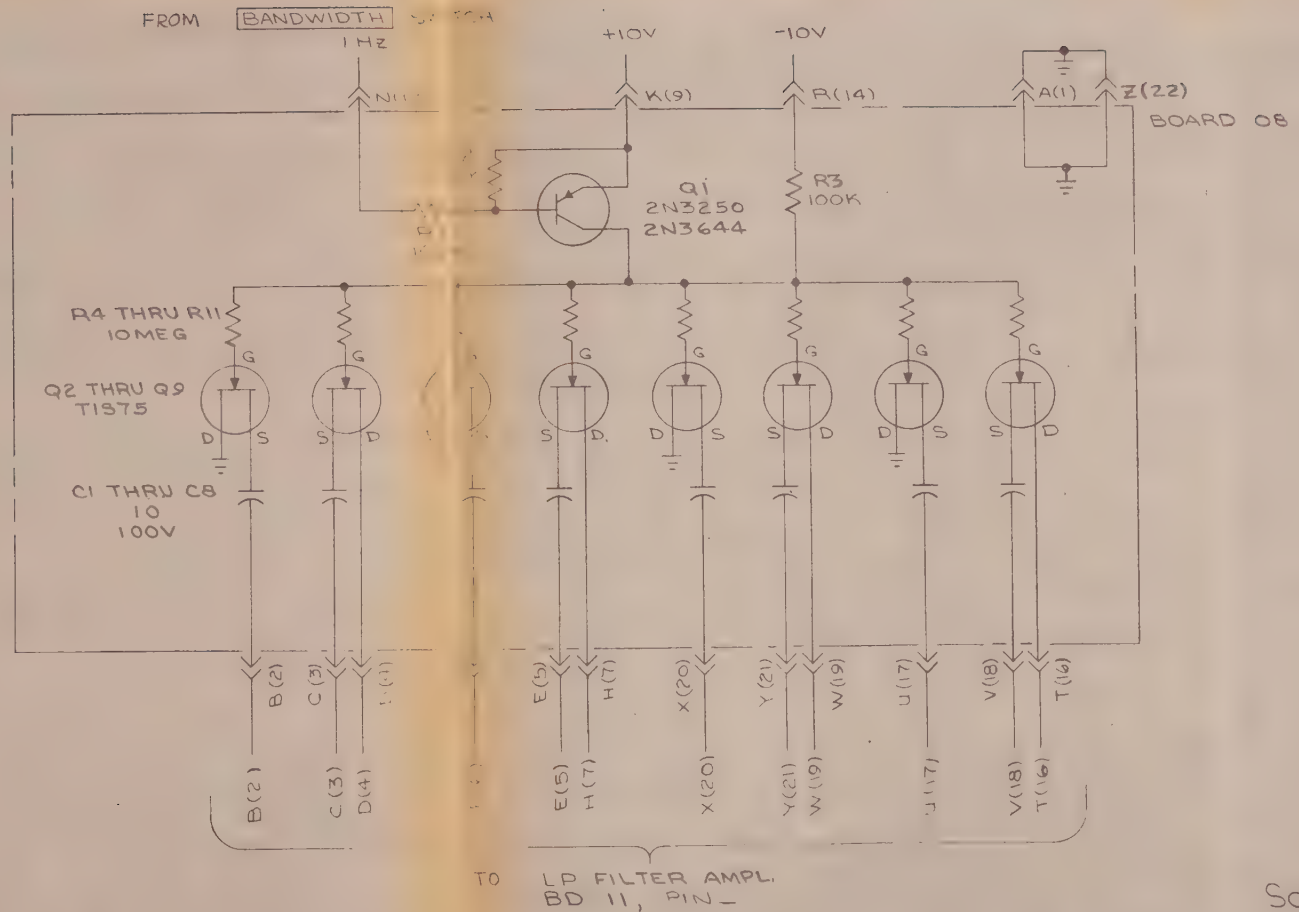
SCHEMATIC
SUMMING AMPLIFIER
AND DETECTOR
MODEL 304TDL

C-8189 A



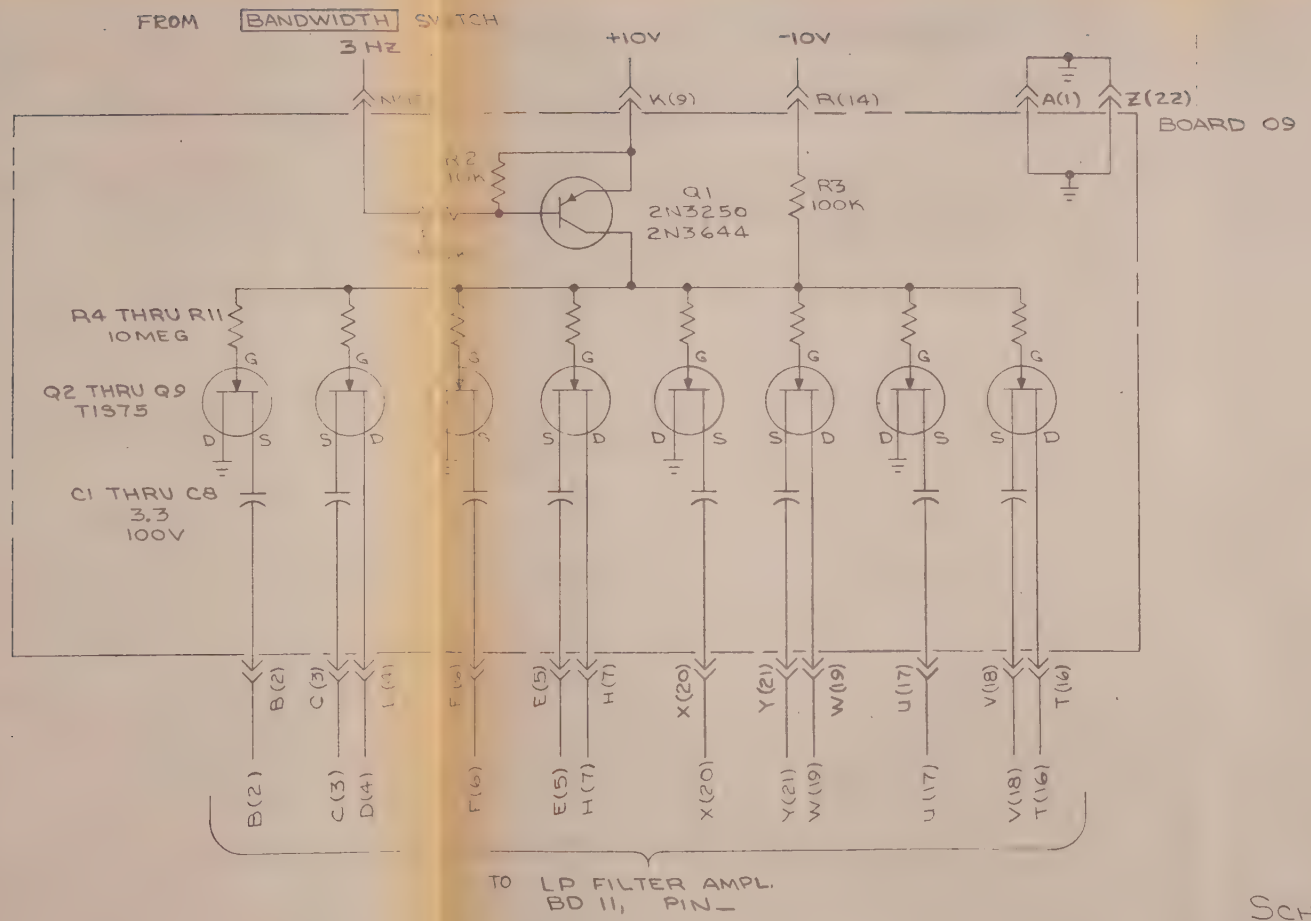
SCHEMATIC
SUMMING AMPLIFIER
AND DETECTOR
MODEL 304TDL

T-8189 A



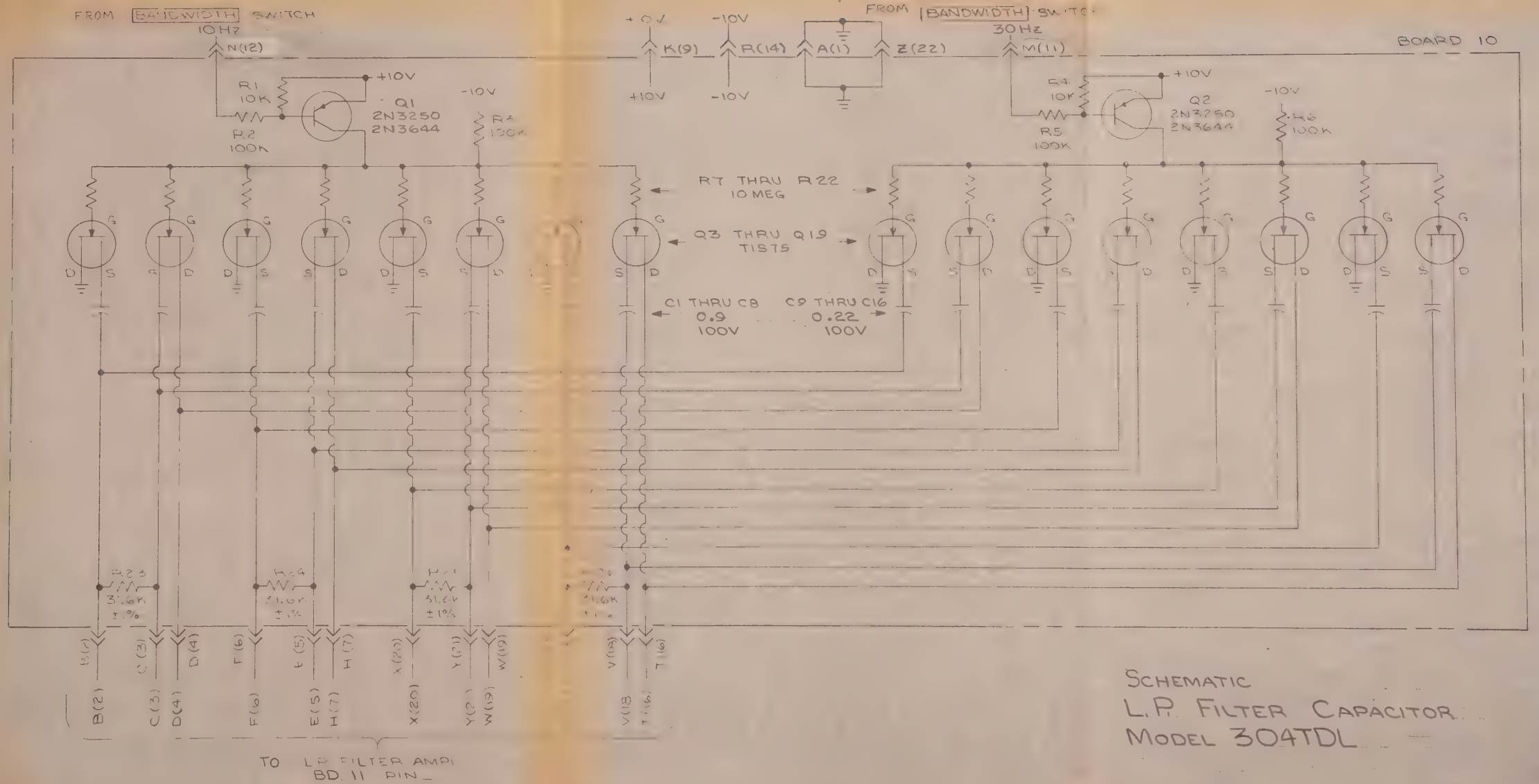
SCHEMATIC
L.P. FILTER CAPACITOR
MODEL 304TDL

T-8190 A



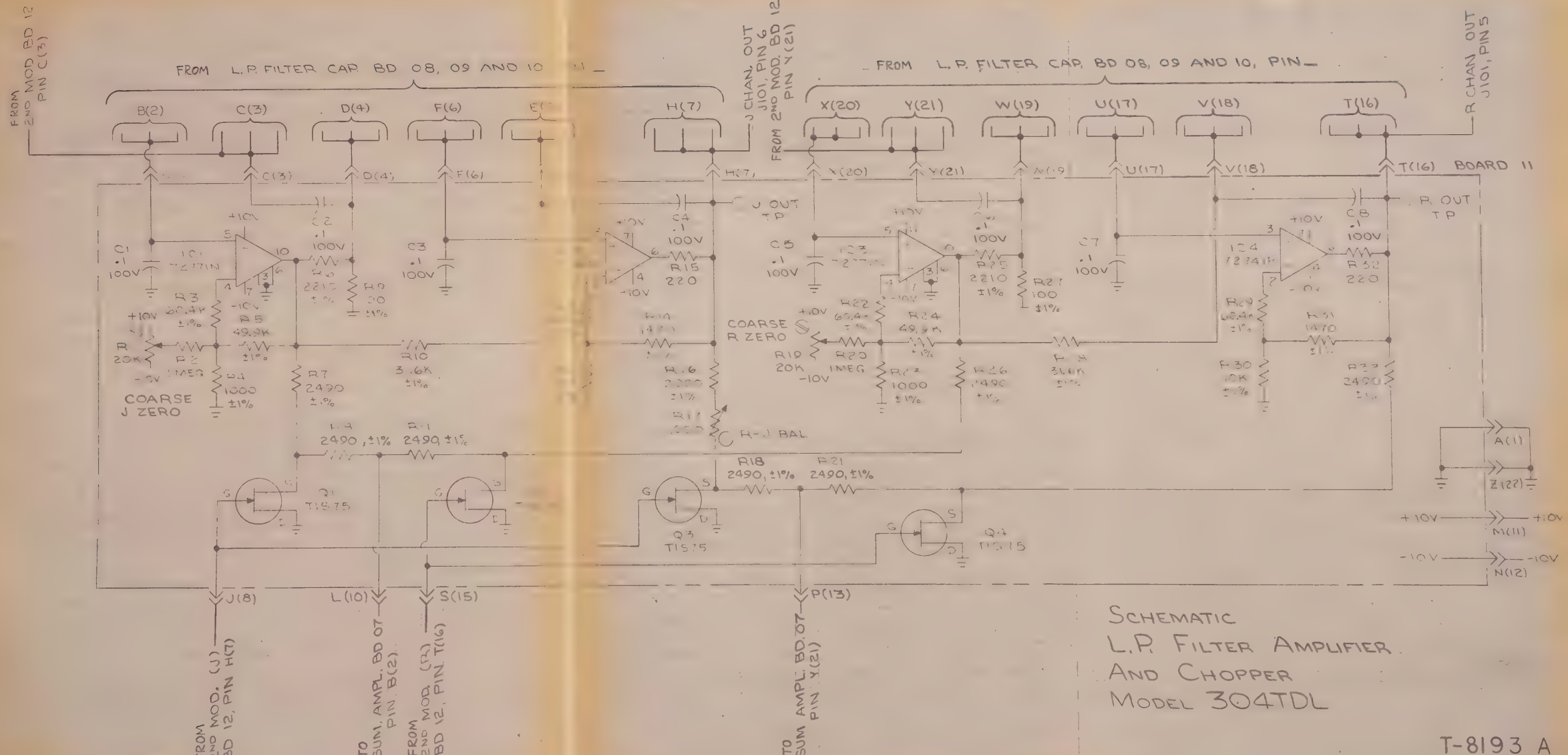
SCHEMATIC
L.P. FILTER CAPACITOR
MODEL 304TDL

T-8191 A



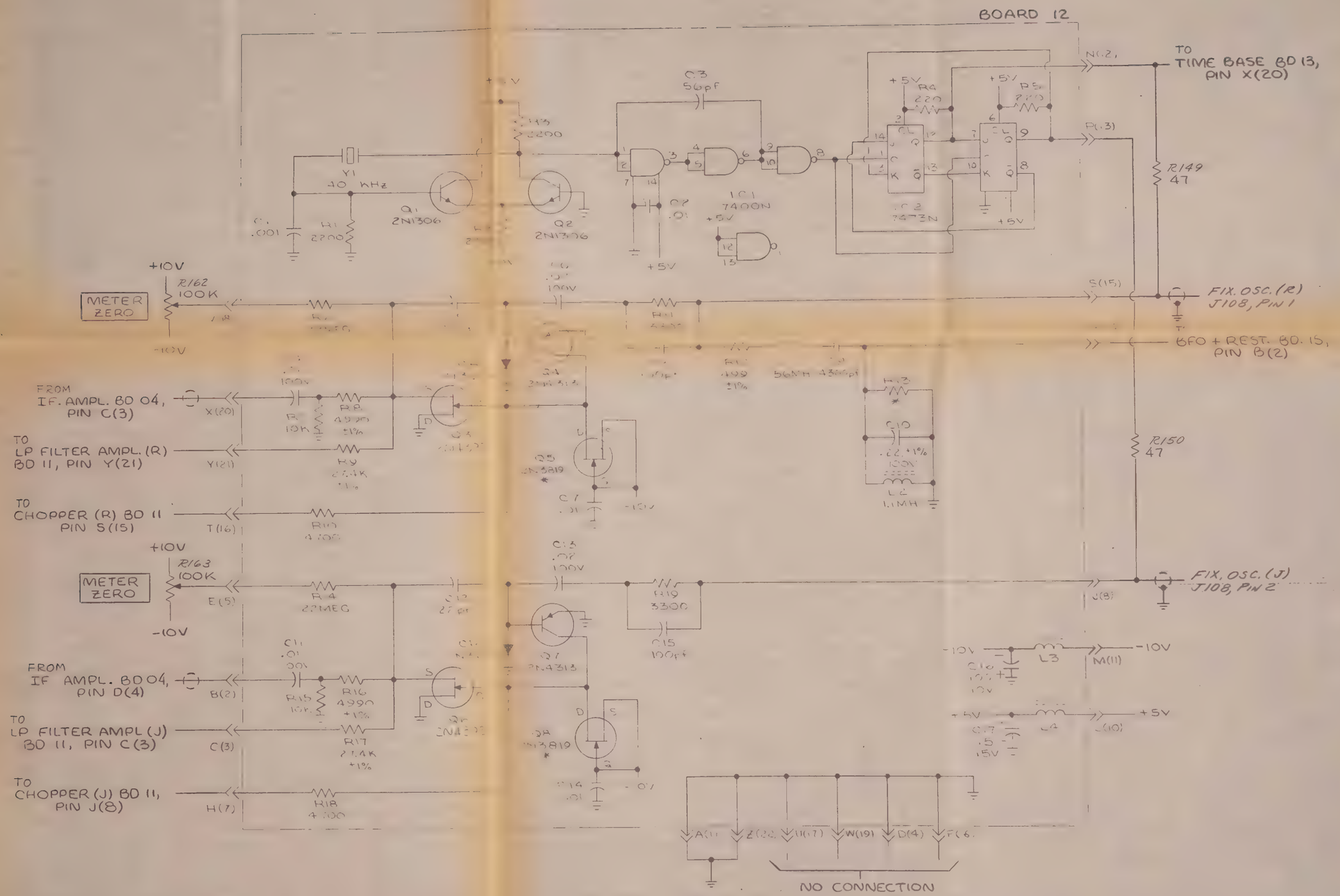
SCHEMATIC
L.P. FILTER CAPACITOR
MODEL 304TDL

T-8192 A



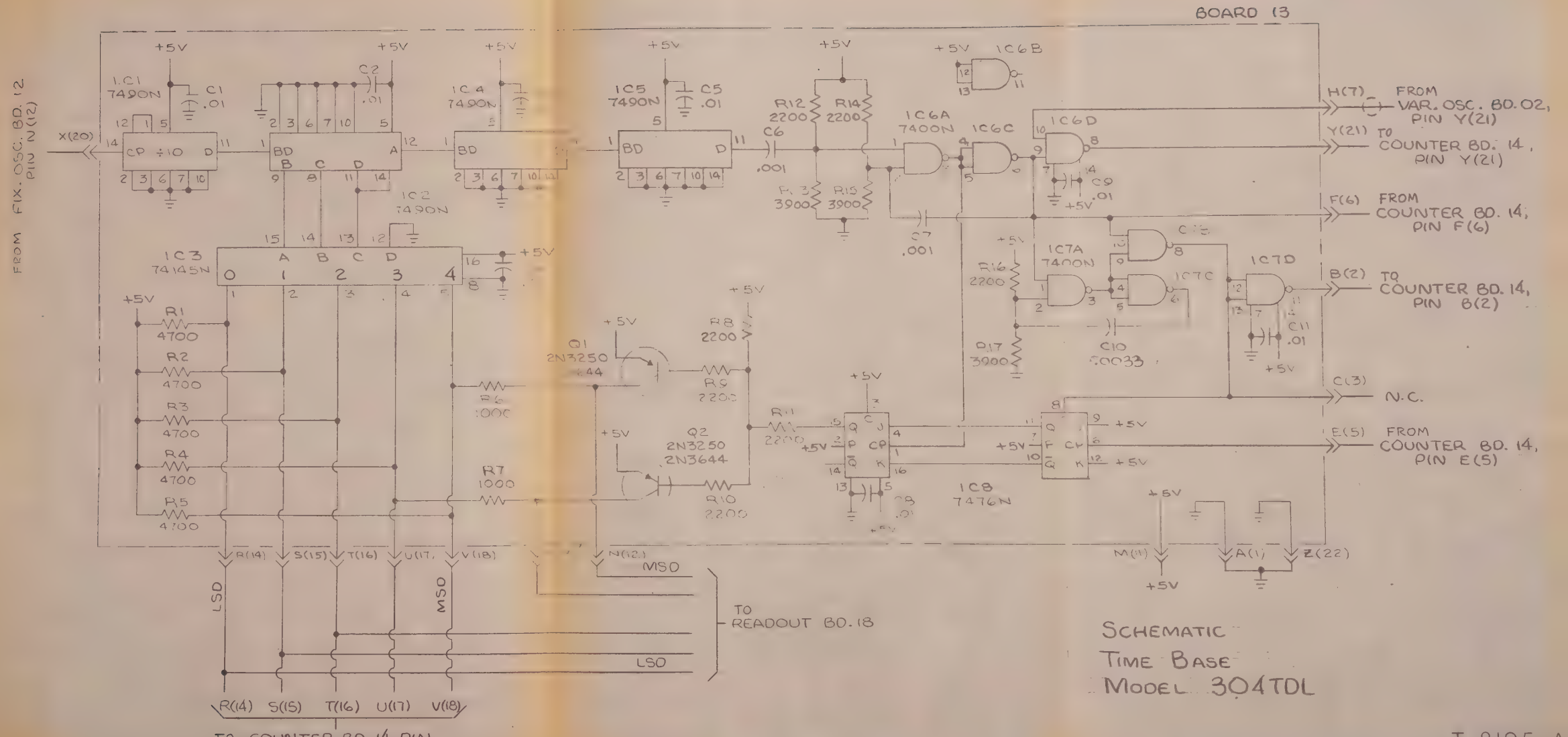
Schematic
L.P. Filter Amplifier And Chopper
Model 304TDL

T-8193 A



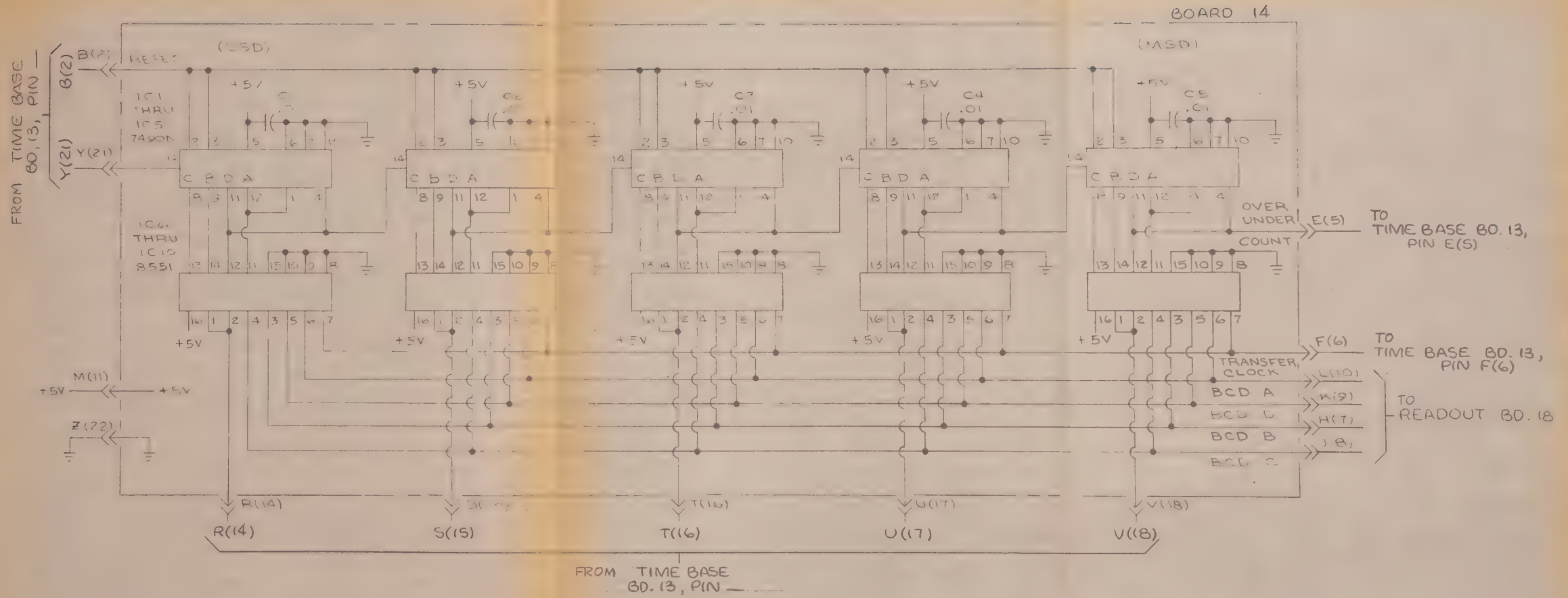
SCHEMATIC
FIXED OSCILLATOR AND
2ND MODULATOR
MODEL 304 TDL

C-8194 A



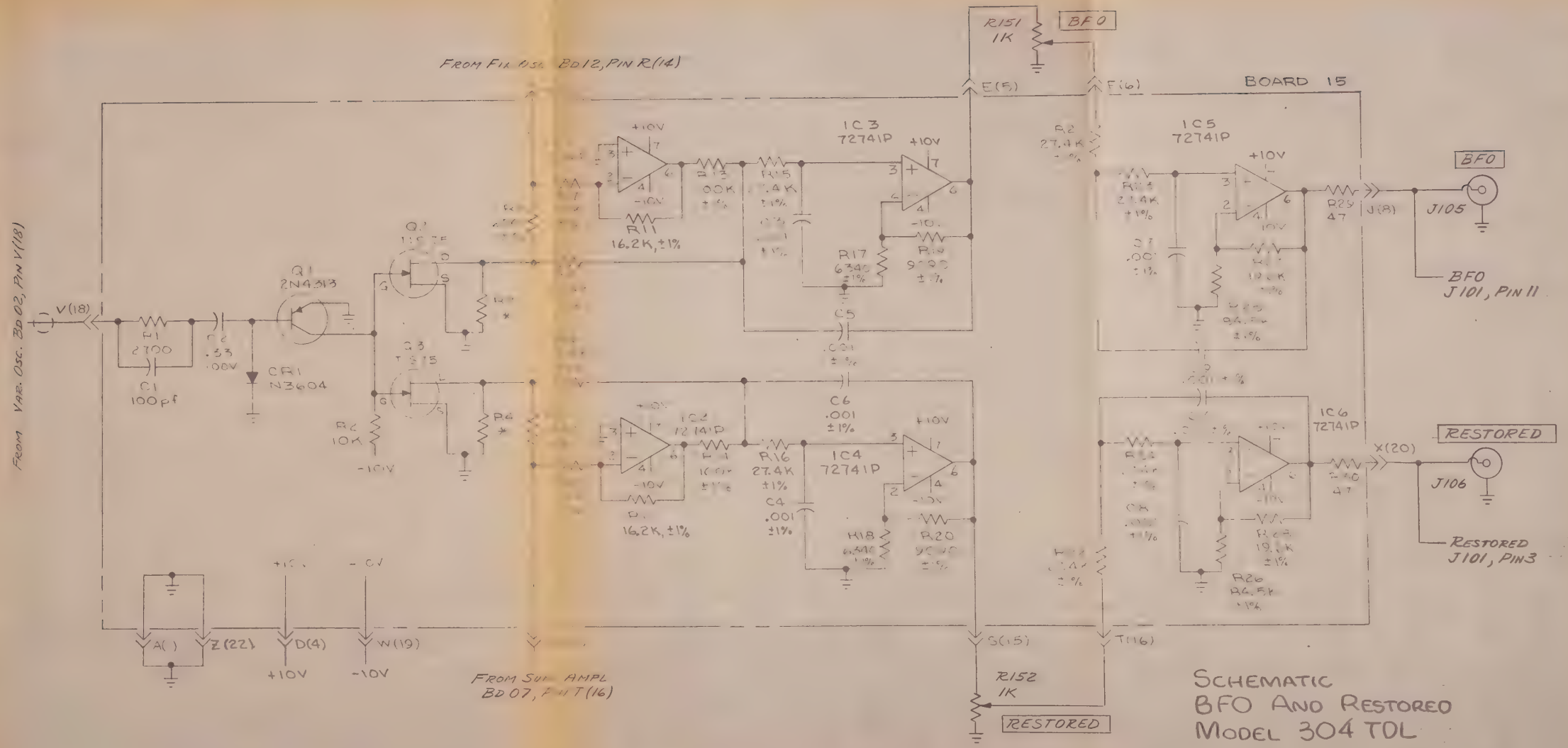
SCHEMATIC
TIME BASE
MODEL 304TDL

T-8195 A



SCHEMATIC
COUNTER AND MULTIPLEXER
MODEL 304 TDL

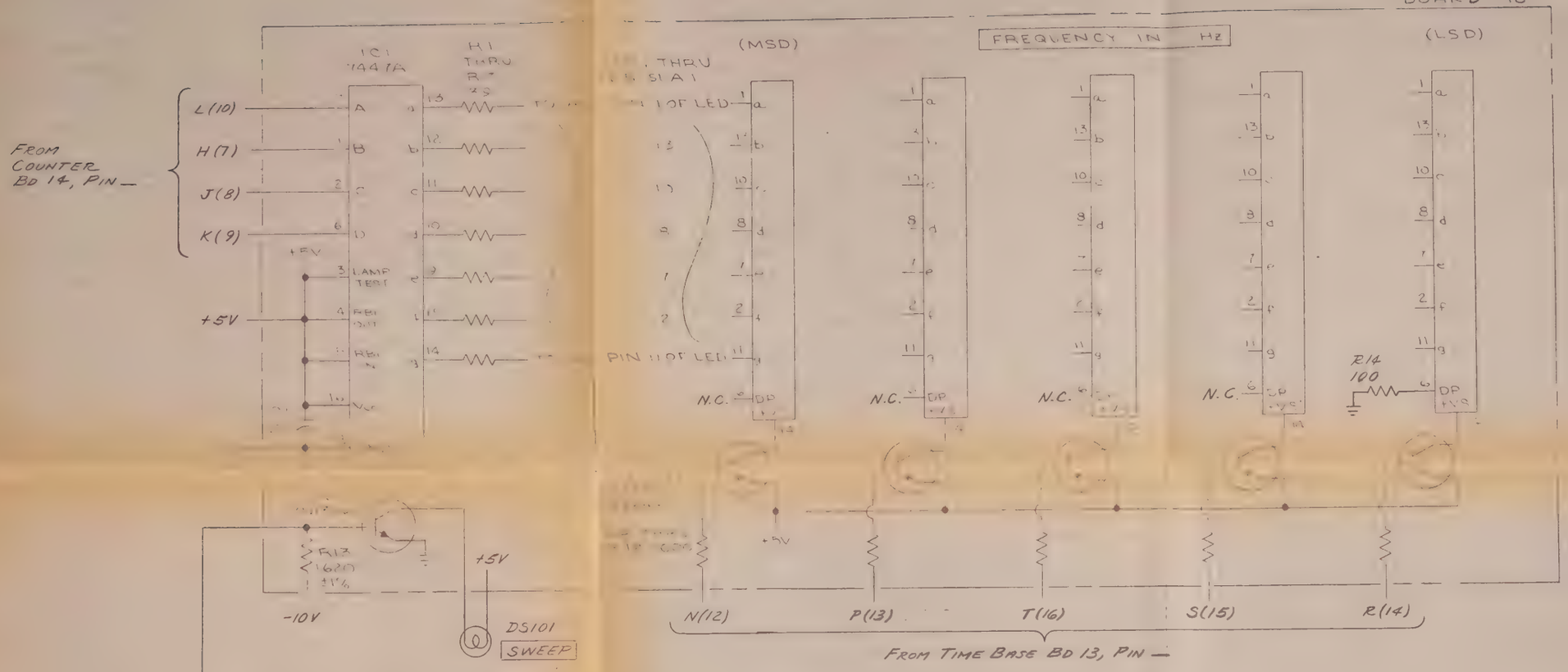
T-8196 A

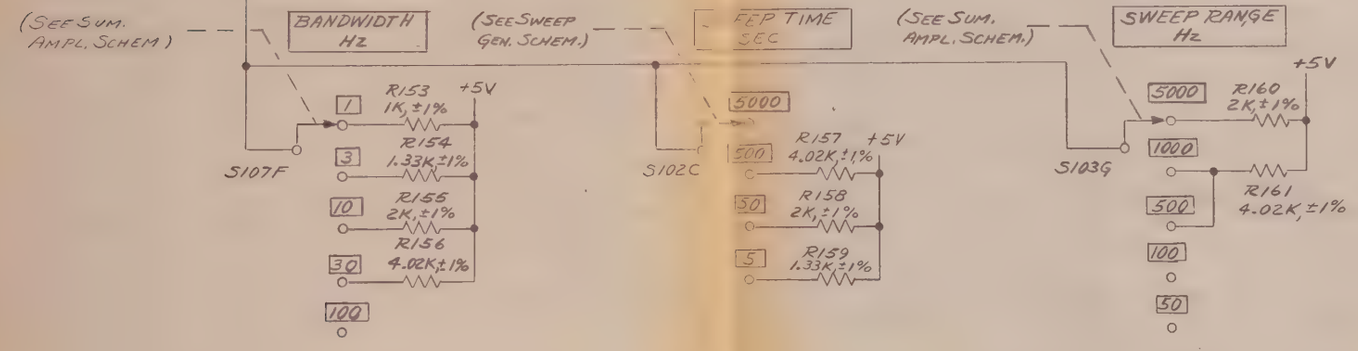


SCHEMATIC
BFO AND RESTORED
MODEL 304 TDL

T-8197 A

BOARD 18





SCHEMATIC
READOUT AND
LAMP CIRCUIT
MODEL 304TDL

C-8198 A

IMPORTANT

Notice to the User of this Instrument....Do you want to be kept up-to-date on measurement techniques, applications, and new instrumentation? Periodically Quan-Tech publishes technical papers and application notes that may increase the usefulness of your instrumentation.

We will be happy to add your name to this mailing list after receiving the attached prepaid postcard. The information we request will permit us to serve you better, and insure timely delivery of pertinent information.

We suggest the following record be kept for registration, modifications, repairs, etc.

Quan-Tech®

INSTRUMENT RECORD

Manual registered on _ _ _ _ _ _

User's name _ _ _ _ _ _ _ _ _ _

Company _ _ _ _ _ _ _ _ _ _ _ _

Div./Dept _ _ _ _ _ _ _ _ _ _ _

Street _ _ _ _ _ _ _ _ _ _ _ _

City _ _ _ _ _ _ _ _ _ _ _ _ _

State/Zip _ _ _ _ _ _ _ _ _ _ _

Instrument Record:

(Continued on other side)

Detach This Card First

INSTRUMENT REGISTRATION

Model No. _ _ _ _ _ _ _ _ _ _

Serial No. _ _ _ _ _ _ _ _ _ _

Options _ _ _ _ _ _ _ _ _ _

Company _

Div./Dept. _

Street _

City/State/Zip _

Name of User _

Title _ Telephone _ _ _ _ _ _

Instrument used in ☐Research/Development ☐Production/Manufacturing

☐Test/Quality Control ☐Service/Maintenance ☐Other _ _ _ _ _ _ _ _

Application _

_ _

_ _

May we contact you for comments or suggestions on this instrument/manual?

Use This Card Only For Revision

CHANGE OF ADDRESS OR REGISTRATION

Model No. _ _ _ _ _ _ _ _ _ _

Serial No. _ _ _ _ _ _ _ _ _ _

Options _ _ _ _ _ _ _ _ _ _

Company _

Div./Dept. _

Street _

City/State/Zip _

Name of User _

Title _ Telephone _ _ _ _ _ _

Instrument used in ☐Research/Development ☐Production/Manufacturing

☐Test/Quality Control ☐Service/Maintenance ☐Other _ _ _ _ _ _ _ _

Application _

_ _

_ _

May we contact you for comments or suggestions on this instrument/manual?

Quan-Tech®

INSTRUMENT RECORD (Continued)

FIRST CLASS
Permit No. 25
WHIPPANY,
NEW JERSEY

BUSINESS REPLY CARD

No Postage Stamp Necessary if Mailed in The United States

Postage Will Be Paid By:

Quan-Tech®
Division of KMS Industries, Inc.

43 SOUTH JEFFERSON ROAD
WHIPPANY, NEW JERSEY 07981

FIRST CLASS
Permit No. 25
WHIPPANY,
NEW JERSEY

BUSINESS REPLY CARD

No Postage Stamp Necessary if Mailed in The United States

Postage Will Be Paid By:

Quan-Tech®
Division of KMS Industries, Inc.

43 SOUTH JEFFERSON ROAD
WHIPPANY, NEW JERSEY 07981